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A COMPUTER CALCULATION AND DISPLAY SYSTEM FOR SLOSH HURRICANE SURGE MODEL DATA

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EDITOR'S NOTE

It is not our customary practice to publish computer programs for systems other than AFOS. We have made an exception in this case because of the potential value of this program to hurricane-prone areas. In order to use this program at locations other than Charleston, SC, Phase II of SLOSH must be completed for those locations and the results incorporated in this program.

NOTICE TO USERS

The information provided by this computer program was developed by utilizing "SLOSH", the National Weather Service storm-surge model. The SLOSH model, like any other operational model, is subject to prediction errors. Some of these are inherent in the model itself; others are related to initial data uncertainties; still others are tied to our incomplete understanding of air-sea interaction. The model was specifically developed for use in preparing community evacuation plans and as guidance in operational forecasting. Accordingly, the National Weather Service assumes no responsibility for further uses or interpretation of the SLOSH model output without its specific written concurrence.

NOTE: These values may differ significantly from those developed by the Federal Emergency Management Agency to delineate flood hazard zones and to assign actuarial rates under the National Flood Insurance Program (NFIP). NFIP values should not be used for hurricane evacuation planning, and storm evacuation values developed from the SLOSH model and this program should not be used for setting insurance rates.

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I. Summary

The National weather Service (NWS) has used computer models since the 1960's to simulate the effects of hurricanes as they approach land. These models, named SPLASH (Special Program to List the Amplitudes of Surges from Hurricanes) and SLOSH (Sea, Lake and Overland Surges from Hurricanes), compute storm surge heights under hypothetical hurricane conditions. The SPLASH model is useful for modeling hurricane effects along relatively smooth coastlines, while the SLOSH model is used for irregular coastlines, especially those with major bays and estuaries. The SLOSH model, which is able to gauge flooding for inland areas, is considerably more sophisticated than the SPLASH model. These models, especially SLOSH, have been increasingly used by local planners to determine evacuation routes to use during hurricane conditions.

The Government Accounting Office found that local planners who have used simulations of this type believe them to be "indispensable" to effective planning, and the National Weather Service, Federal Emergency Management Agency (FEMA), the Corps of Engineers and GAO have all agreed that the SLOSH model is the most useful in providing comprehensive information for state-of-the-art planning.

The SLOSH model has to be specifically adapted for each coastal flood basin, a process known as Phase I. In order to provide detailed data from the model for use by planners, Phase II must be completed. In this phase, NWS will run an average of 250 simulations (or hurricane tracks) on the SLOSH model for each basin. This will eventually be completed for at least 21 basins of Coastal U.S. If funding is available, information obtained from the model is summarized and printed as a reference document.

During Hurricane Alicia, in Texas, SLOSH model data was available and most officials were familiar with the model, but encountered various difficulties in attempting to use SLOSH data during the storm. A few expressed the opinion that the data was in too complex a form to be helpful during the storm itself, according to a Congressional report. Finding the correct printed data, then calculating and plotting the data, can be a time consuming task, when several locations must be calculated during an extremely busy hurricane threat condition. In addition, when the strike point of the storm changes (possibly several times a day), all new calculations and plots must be performed using the printed data. For those areas with large tidal ranges, such as along the South Carolina coast (5-8 feet)

additional calculation and plotting must be done to take into account the state of the tide at the time of hurricane strike. A computer calculation and display system has been developed to help insure real-time updating of the latest information from the SLOSH model as conditions change under hurricane threat.

After the SLOSH program (Phase I and II) is completed for a coastal basin, the output from the model is made available in computer printout form. These printouts constitute detailed data for scores of coastal points for 250 different combinations of storm track and storm intensity. From this volume of data, a set of 12 representative coastal points are selected...and time histories of storm surge and winds are transcribed from the printouts onto forms. From these forms, the data is entered into the minicomputer (described below) as BASIC language data statements (shown in Appendix A) which describe the storm surge profile for each point.

For planning purposes, any combination of storm track and intensity can be selected, along with time of arrival and time of high tide, to arrive at an almost infinite combination of possible storm conditions. Worst-case scenarios may then be developed, and timing of evacuation and location of shelters may then be refined.

In operational use, when hurricane conditions threaten, the user will obtain information on the expected storm track and intensity from the National Hurricane Center, and utilize local tide tables for tidal input to the program. These parameters will then be entered into the minicomputer and profiles for each of the representative coastal points will be quickly available either on screen or in printout form (hard copy). If the track or timing of the storm changes, the user would enter the new strike location and arrival time, and new surge profiles for each point would be available.

As shown in Figures 1 and 2, the model is capable of producing very good estimates of storm surge, given an accurate forecast track as input into the program. This means that in operational use, the program will be updated as each major change in forecast track occurs. The accuracy of the program will then approach the maximum accuracy of the SLOSH model when the strike point of the storm is relatively certain (in the last few hours before strike or earlier, if the storm is a very predictable one).

II. The SLOSH Display System

A. Hardware

Although each National Weather Service Office is equipped with an AFOS (Automation of Field Operations and Services) computer system, in normal use each computer handles a very large amount of information. Under hurricane threat, the system is under even more strain, in order to produce the increased amount of information demanded by the public. The addition of an interactive computer program to this system at such a time could cause, at the least, unacceptable periodic software overloads and interruption of use of AFOS at a critical time. For this reason, a separate relatively inexpensive system was chosen, which would also allow portability of the hardware and usage at other locations for planning purposes.

The hardware consists of the following:

1. Radio Shack 64K TRS-80 Color Computer (Extended BASIC)
   Catalog number 26-3003
2. Radio Shack Color 2 Disk Drive #10
   Catalog number 26-3029
3. Color Television Set - preferably of good quality
   Size 12" probably ideal for desk-top operation
4. Radio Shack Color Ink-Jet Printer CGP-220 (for hard copies)
   Catalog number 26-1268
5. Diskettes (at least 10-pack)
   Catalog number 26-406

Note--All necessary cables and plugs for computer and disk, as well as disk operating system, included as standard equipment.

B. Software

The main program, called SLOSH1, is written in TRS-80 Color Extended BASIC language (under license from Microsoft Corp.). It is written for the TRS-80 Disk Operating System and resides on each disk in the system. When the main program is called from the disk, it merges itself with smaller programs residing on the same disk, which represent the different hurricane tracks. There are about 250 of these small programs on 5 separate disks.

The main program is menu-driven, meaning that the screen provides you with several choices to make. The operator merely follows the directions and selects the options to make a hurricane storm surge chart for the particular track selected. Several machine-language routines were written especially for this program. They are called by the main program to produce alphanumerics on the graphic screen and to produce printouts of the screen from the printer. These routines are written in 6809E Machine Code. A complete description of this software and listings of the program will be in Appendix A.

III. Usage of the System

* TURN ON ALL EQUIPMENT

* INSERT DISK IN DISK DRIVE - Choose the storm intensity (1-5) disk you desire. (Drive motor should be on)

* ON THE KEYBOARD...TYPE RUN "S" (ENTER)
  Screen will display contents of disk and ask you to select either a number (representing a storm track) or "N" for next page

* TYPE EITHER A NUMBER (ENTER) or N (ENTER) for next page
  Note - track 3NW12L60 means Cat. 3 storm
  moving Northwest at 12
  striking 60 miles Left of Reference point

  If you go to the next page...more tracks will be displayed and you can select a track (number) or return to first page ("F")

  If a number is entered representing a storm track...the program will first load the main program (SLOSH1) and then merge the selected track into it. The screen will clear and it will ask you to run the program as soon as an "OK" prompt is displayed.

* * AFTER "OK" PROMPT... TYPE RUN (ENTER)
  Screen will clear and a menu will display on the screen. This is the Main Menu of the program and offers several selections.
  1. Set arrival and Tide Times-
  2. Graph Surge Only-
  3. Graph Tide and Surge-
  4. List Max. Surge (All)-
  5. List Max. Tide + Surge (All)-

  If you want to set a specific time of arrival for the storm...or want to factor in tides...then TYPE 1 (ENTER)
  Screen will clear and you must enter time of arrival (local time) in four digits (0700,1200,1800,etc.) to the nearest whole hour. This is time of landfall, or if paralleling storm...then time of closest approach to reference location (in this case, Charleston). TYPE (TIME) (ENTER)

  Then enter time of High Tide at reference point...which occurs

between the hours displayed on the screen...if wrong entry, it will ask you again. Example of correct entry 0600 for 0900 arrival time
...incorrect entry 1000 for 0900 arrival time
Tide times may be fractions of hours...0635, 1020, etc.

TYPE (TIDE TIME) (ENTER)

Press any key to return to Main Menu.

(From Main Menu)
If you want to display only the surge from the storm (without the effect of tides) TYPE 2 (ENTER)

Screen will clear...and you are asked to select a number representing the location you want.

TYPE (LOCATION NUMBER) (ENTER)

Screen will clear...and a graph will be drawn representing only the storm surge for that location. Times displayed on the screen will be constant unless they are set previously using Step 1. Display will stay on screen until one of the following keys are pressed:

"M" Returns to Main Menu
"P" Jumps to Print Routine
BREAK Breaks program. To start again you must type RUN (ENTER)

(From Main Menu)
If you want to display the effects of storm surge plus tides..... then TYPE 3 (ENTER)

Screen will clear...and you are asked to select a number representing the location you want.

TYPE (LOCATION NUMBER) (ENTER)

Screen will clear...and a graph will be drawn representing the total storm tide (Tide + Surge) for that location. The time of arrival and tides must have been entered in Step 1 or you will be routed back to that step to enter times.

Display will remain on the screen until one of the following keys is pressed:

"M" Returns to Main Menu
"P" Jumps to Print Routine
BREAK Breaks program. To start again you must type RUN (ENTER)

(From Main Menu)
To list the maximum surge for this track at each of the locations regardless of time that it occurred...TYPE 4 (ENTER)

(From Main Menu)
To list the maximum total storm tide (Tide + Surge) for each location, regardless of time that it occurred...TYPE 5 (ENTER)

If time of tides and arrival time of storm has not been set in Step 1, you will be returned to that routine to set times.

(In Print Routine) - Print Routine is entered by pressing "P" when graph is displayed.

Screen displays a choice between a half-size and full-size printout. Make your choice by typing:

H	(ENTER)	for half-size
F	(ENTER)	for full-size

Half Size Print

Screen prompts you to prepare printer. Turn on printer and make sure ready light on printer is on.
When printer is ready... Press (ENTER)

When using the half-size print...the program will display the graph on screen while printing. Keys are disabled during the printing. When finished...if you wish to return to the Main Menu...Press "M" .

Full-Size Print

Screen prompts you to insert print routine disk in the disk drive...then Press (ENTER)

Screen prompts you to prepare printer. Turn on Printer and make sure ready light on printer is on.
When printer is ready...Press (ENTER)

Screen prompts you to press Right Arrow and then press "D". Printer will start printing. Printout on full-size may be broken at any time by pressing BREAK twice.
After printing...you may run the main program again by typing RUN (ENTER).

IMPORTANT - After running full-size printout...you may not load any other program from disk or that program will fail and possibly cause problems on the disk. When you want to run another track or another program (other than the one you are currently running)...first TYPE RUN 900 (ENTER)

REFERENCES

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APPENDIX A - Program Listing

```
100 '**************************
200 '* HURRICANE SURGE PROGRAM *
300 '* USING "SLOSH" HURRICANE *
400 '*   SURGE MODEL OUTPUT    *
500 '*  JOHN F. TOWNSEND       *
600 '* NATIONAL WEATHER SERVICE*
700 '*   CHARLESTON S.C.       *
800 '*  VERSION 1.0   1/20/84  *
850 '**************************
860 GOTO 1000
900 POKE113,3:EXEC40999
1000 IF PEEK(&H7F00)=99 THEN RUN 1200
1050 IF PEEK(&H7FFE)=99 THEN GOTO 1600
1100 GOTO 1300
1200 FOR I=1TO8:L$=L$+CHR$(PEEK(&H7F00+I)):NEXT:CLS:PRINT"***LOADING SLOSH ";L$;"***":PRINT
"...WAIT FOR OK..THEN RUN...":POKE&H7F00,0:MERGE L$
1300 CLEAR200,&H7700
1400 PCLEAR4
1500 LOADM"CHR/BIN":POKE&H7FFE,99
1600 DIM TM(24):DIM TD(48):DIM S(24):DIM TS(24):DIM MS(15):DIM MT(15)
1700 L=31944:DEFUSR8=L:DEFUSR9=L+10:GOTO 1900
1800 W=USR8(A):W$=USR9(A$):RETURN
1900 'MENU
2000 CLS:PRINT"      WSO- CHARLESTON S.C.":PRINT@33,STRING$(3,42);:PRINT"hurricane"+CHR$(12
8)+"surge"+CHR$(128)+"program"+STRING$(4,42);:PRINT@65,"* USING 'SLOSH' MODEL OUTPUT *";:P
INT@97,STRING$(30,42)
2100 GOSUB 20000:PRINT@130,"CAT."+LEFT$(H$,1)+"  MOVING "+MID$(H$,2,4)+"  "+RIGHT$(H$,3)+"
/ CHS"
2200 PRINT@200,"---"+CHR$(128)+"menu"+CHR$(128)+"---":PRINT@226,"<1> SET ARRIVAL+TIDE TIMES
":PRINT@258,"<2> GRAPH SURGE ONLY":PRINT@290,"<3> GRAPH TIDE + SURGE"
2300 PRINT@322,"<4> LIST MAX.SURGE(ALL)":PRINT@354,"<5> LIST MAX.TIDE+SURGE(ALL)"
2400 PRINT@422,"YOUR CHOICE...";:INPUTC1
2500 C2=0
2600 IF C1>1 THEN GOTO 7000
2700 IF C1=1 THEN CLS:GOTO 2800
2800 CLS:PRINT"***USE EASTERN DAYLIGHT TIME***":PRINT@32*2+1,"ENTER TIME OF LANDFALL...OR
   CLOSEST APPROACH TO CHARLESTON  IF MOVING PARALLEL TO COAST...  TO NEAREST WHOLE HOUR.
       example  1500,0900, 2100 ETC.":INPUT " ENTER HERE>>>";TA
2900 IF RIGHT$(STR$(TA),2)<>"00" THEN 2800
3000 IF TA>2400 OR TA<0 THEN 2800
3100 FT=TA-1200:IF FT<0 THEN FT=TA+1200
3200 PRINT:PRINT" NOW ENTER TIME OF HIGH TIDE     AT  CHARLESTON..... BETWEEN     ";RIGHT$(
STR$(FT+10000),4);"  AND ";RIGHT$(STR$(TA+10000),4);:INPUT" >>>";HT
3300 IF TA>1100 THEN IF  HT>TA OR HT<FT THEN 3500
3400 IF TA<1200 AND HT<TA OR HT>FT THEN 3600
3500 INPUT" NOT IN BETWEEN ABOVE TIMES...   ENTER AGAIN...";HT:GOTO 3300
3600 PRINT:PRINT:PRINT" PRESS ANY KEY TO CONTINUE...";
3700 K$=INKEY$:IF K$="" THEN 3700
3800 GOTO 2000
```

```
3900 RESTORE:E=0 'READ DATA
4000 READ NO:E=E+1:IF NO=999 THEN RETURN
4100 MS(E)=0:EX=1
4200 READ L$,TR,TC
4300 FOR I=0 TO 24:READ S(I):S(I)=S(I)/10
4400 IF S(I)>MS(E) THEN MS(E)=S(I)
4500 IF S(I)>11 OR S(I)<-6 THEN EX=2
4600 IF S(I)<-10  THEN S(I)=-10
4700 NEXT
4750 READ BG,BH,EH,EG
4800 IF C1=4 THEN PRINT@32*E+26,MS(E);
4900 READ X$:IF X$<>"X" THEN CLS:PRINT" ERROR IN LINE ";E*10+20000:END
5000 IF C1=5 THEN GOTO 5400
5100 IF NO<>C2 THEN 4000
5200 RETURN
5300 'COMPUTE TIDES
5400 IF HT=0 THEN GOTO 2800
5500 HI=HT+TC
5600 DT=HI-FT:IF DT<0 THEN DT=2400-FT+HI
5700 FOR I=0 TO 48:TD(I)=COS(((2500-DT)/2500)*12.5663706+I*.251327412)*TR
5800 NEXT
5900 'COMBINE TIDE+SURGE
6000 MT(E)=0:EX=1
6100 FOR I=0 TO 24
6200 TS(I)=TD(I*2)+S(I)
6300 IF TS(I)>MT(E) THEN MT(E)=TS(I)
6400 IF TS(I)>12 OR TS(I)<-7 THEN EX=2
6500 IF TS(I)<-11 THEN TS(I)=-11
6600 NEXT
6700 IF C1=5 THEN PRINT@32*(E+1)+26,USING"##.#";MT(E);
6800 IF C1=5 THEN 5100
6900 RETURN
7000 'PRINT LIST+CHOICE
7100 IF C1=2 OR C1=3 THEN CLS:PRINT"**SURGE PROGRAM LOCATION LIST**"
7200 IF C1=4 THEN CLS:PRINT" ***MAXIMUM SURGE***        MSL"
7300 IF C1=5 THEN CLS:PRINT" ***MAXIMUM(TIDE+SURGE)***  MSL":PRINT" ARR.";TA;"-HIGH TIDE CH
S";HT
7400 PRINT" <1>HILTON HEAD-F.F.BCH":PRINT" <2>BROAD RIVER-5 W OF NBC":PRINT" <3>SEABROOK IS
LAND":PRINT" <4>DAWHOO RIVER":PRINT" <5>STONO RIVER":PRINT" <6>STONO INLET-KIAWAH":PRINT" <
7>ASHLEY RIVER 10NW CHS":PRINT" <8>CHARLESTON HARBOR"
7500 PRINT" <9>HIGHWAY 41-WANDO RIVER":PRINT" <10>GOOSE CREEK":PRINT" <11>GEORGETOWN-WINYAH
 BAY":PRINT" <12>MYRTLE BEACH":PRINT
7600 IF C1<4 THEN PRINT" your"+CHR$(128)+"choice>>>";
7700 IF C1=4 OR C1=5 THEN PRINT@32*14+2,"**computing...PLEASE WAIT**";:GOSUB 3900 ELSE GOTO
 8100
7800 IF C1>3 THEN PRINT@32*14+2," PRESS ANY KEY FOR menu>>>";
7900 K$=INKEY$:IF K$="" THEN 7900
8000 GOTO 2000
8100 INPUT C2
8200 PRINT" ***COMPUTING...***";
8300 EX=1:GOSUB 3900
```

```
8400 IF C1=3 GOSUB 5300
8500 PMODE4,1:PCLS5:SCREEN 1,1:COLOR 0,5
8600 FI=TA/100-12:IF FI<0 THEN FI=24+FI
8700 FOR I=0 TO 24 STEP 3
8800 TM(I)=FI+I
8900 IF TM(I)>23 THEN TM(I)=TM(I)-24
9000 IF TM(I)<10 THEN A=21*32+4+I:A$=STR$(TM(I)):GOSUB1800:A$="0":GOSUB1800:GOTO 9300
9100 A=21*32+3+I:A$=STR$(TM(I))
9200 GOSUB 1800
9300 NEXT I
9400 A=4:A$=" HURRICANE SURGE PROGRAM ":POKE L+77,18:GOSUB 1800:POKE L+77,67
9500 A=32+2:A$="CAT."+LEFT$(H$,1)+"  MOVING "+MID$(H$,2,4)+"  "+RIGHT$(H$,3)+" / CHS":GOSUB
 1800
9600 DRAW"BM230,2R17D16L239U16R25"
9700 A=3*32+1:A$="MSL":GOSUB1800
9800 A=3*32+6:A$=L$:GOSUB1800
9900 A=3*32+28:A$="MLW":GOSUB1800
10000 A=4*32+1:A$=STR$(10*EX):GOSUB 1800
10100 A=4*32+28:A$=STR$(10*EX+3):GOSUB1800
10200 A=9*32+1:A$=STR$(5*EX):GOSUB 1800
10300 IF 5*EX+3>9 THEN A=9*32+28:A$=STR$(5*EX+3):GOSUB1800 ELSE A=9*32+29:A$=STR$(5*EX+3):G
OSUB 1800
10400 A=14*32+1:A$=STR$(0):GOSUB 1800
10500 A=14*32+29:A$=STR$(3):GOSUB1800
10600 A=19*32+1:A$=STR$(-5*EX):GOSUB 1800
10700 A=19*32+29:A$=STR$(-5*EX+3):GOSUB1800
10800 FOR I=4 TO 19
10900 A=I*32+4:A$=STRING$(25,"]"):GOSUB 1800:NEXT
11000 LINE (30,39)-(234,39),PSET:LINE(30,79)-(234,79),PSET:LINE(20,119)-(248,119),PSET:LINE
(30,159)-(234,159),PSET
11100 FOR I=0 TO 8:LINE(40+I*24,35)-(40+I*24,162),PSET:NEXT
11200 IF EX=1 THEN DRAW"BM18,84C0;R10NH3G3":DRAW"BM247,84C0;L10NE3F3":FOR I=41 TO 232 STEP
3:DRAW"BM"+STR$(I)+",86C0E3":NEXT
11300 IF EX=2 THEN DRAW"BM18,100C0;R10NH3G3":DRAW"BM247,100C0;L10NE3F3":FOR I=41 TO 232 STE
P 3:DRAW"BM"+STR$(I)+",103C0E2":NEXT
11400 IF C1=3 THEN A=32*6+8:A$="TOTAL STORM TIDE":GOSUB 1800
11500 IF C1=2 THEN A=32*6+11:A$="SURGE ONLY":GOSUB 1800
11600 IF MID$(H$,2,2)="NE" THEN A=22*32+16:A$="CHS":GOSUB1800:GOTO11720
11700 A=22*32+14:A$="Landfall":GOSUB1800
11720 A=22*32+1:A$="Wind:":GOSUB1800
11730 A=23*32+1:A$="Gale   Hur":GOSUB1800
11750 DRAW"C0BM48,179D11H4"
11760 DRAW"C0BM51,179D11E4"
11770 DRAW"C0BM95,179D11NH4U3H4"
11780 DRAW"C0BM98,179D11NE4U3E4"
11800 A=23*32+17:A$="Tide":GOSUB 1800
11900 A=23*32+24:A$="Surge":GOSUB 1800
12000 DRAW"BM168,189C0;U1R1D1BM+4,-2;U1R1D1BM+4,+2U1R1D1BM+4,-2U1R1D1"
12100 DRAW"BM233,187C0E2F3E3F4"
12200 DRAW"BM136,167;C0;U8NF3G3"
```

```
12300 'PLOT DATA
12400 IF C1=2 THEN 13200
12500 FOR I=0 TO 47
12600 DRAW"BM"+STR$(40+I*4)+","+STR$(INT(120-(TD(I)*8)*(1/EX)))+"C0U1R1D1L1"
12700 NEXT
12800 FOR I=0 TO 23
12900 LINE((40+I*8),INT(120-(TS(I)*8)*(1/EX)))-((40+(I+1)*8),INT(120-(TS(I+1)*8)*(1/EX))),P
SET
13000 NEXT
13100 IF C1=3 THEN GOTO 13405
13200 FOR I=0 TO 23
13300 LINE((40+I*8),INT(120-(S(I)*8)*(1/EX)))-((40+(I+1)*8),INT(120-(S(I+1)*8)*(1/EX))),PSE
T
13400 NEXT
13405 L3=136
13410 IF BG=99 THEN 13420
13415 DRAW"C0BM"+STR$(INT(L3+BG*.08))+",147;D11H4"
13420 IF BH=99 THEN 13430
13425 DRAW"C0BM"+STR$(INT(L3+BH*.08))+",147;D11NH4U3H4"
13430 IF EH=99 THEN 13440
13435 DRAW"C0BM"+STR$(INT(L3+EH*.08))+",147;D11NE4U3E4"
13440 IF EG=99 THEN 13500
13445 DRAW"C0BM"+STR$(INT(L3+EG*.08))+",147;D11E4"
13500 A$=INKEY$:IF A$="" THEN GOTO 13500
13600 IF A$="M" THEN GOTO 2000
13700 IF A$="P" THEN GOTO 13900
13800 GOTO 13500
13900 '***SLOW SCREEN DUMP****
13920 POKE150,18
13940 CLS:PRINT"****SCREEN DUMP ROUTINES*******":PRINT"HALF-SIZE...PRESS H<ENTER>      FULL
-SIZE...PRESS F<ENTER>      >>>>>>";:INPUT Q$
13960 IF Q$="H" THEN CLS:PRINT"PREPARE PRINTER, PRESS<ENTER)":INPUT D$:GOTO 14140
13980 IF PEEK(&H7FFD)=98 THEN 14020
14000 IF Q$="F" THEN CLS:PRINT"INSERT SCREEN DUMP DISK...THEN  PRESS <ENTER>":INPUT D$:LOAD
M"BWDUMP/BIN":POKE&H7FFD,98
14020 CLS:PRINT"PREPARE PRINTER...THEN PRESS    <ENTER)";:INPUT D$:IF D$="TITLE" THEN PRINT
#-2,CHR$(27);CHR$(14);CHR$(27);CHR$(84);CHR$(52);"      NATIONAL WEATHER SERVICE" ELSE GOTO
 14080
14040 PRINT#-2,CHR$(27);CHR$(15);
14060 PRINT#-2,"                          CHARLESTON, SOUTH CAROLINA"
14062 PRINT#-2,CHR$(27);CHR$(84);CHR$(48);
14080 CLS:PRINT"AFTER OK...THEN PRESS RIGHT     ARROW AND THEN PRESS<D>         *****IMPORT
ANT NOTE************** AFTER PRINTING...YOU MAY RUN    THIS PROGRAM AGAIN...BUT YOU    MUST
DO A <RUN900> BEFORE       RUNNING ANY OTHER PROGRAM OR  "
14100 PRINT" THAT PROGRAM WILL FAIL..."
14120 EXEC30661:STOP
14140 SCREEN1,1:EXEC&H7702:GOTO 13500
```

Program Listing - Data Statements (representing 1 track)

```
20000 H$="3NW12L20":RETURN
20010 DATA 1,HILTON HEAD-F.F.BEACH,3.3,-30,10,11,12,13,14,15,16,17,18,15,12,0,-17,-32,-27,-
12,-2,0,-2,-4,-6,-7,-5,-2,1,-810,-200,130,610,X
20020 DATA2,BROAD RIVER-5W NBC,3.5,50,10,10,11,11,12,12,13,13,15,15,10,0,-9,-26,-38,-37,-25
,-11,-1,0,0,0,0,0,0,-700,-130,250,740,X
20030 DATA3,SEABROOK ISLAND,2.8,0,11,12,13,15,17,19,23,28,35,44,48,48,54,47,39,27,16,13,12,
10,7,5,3,5,7,-910,-420,320,700,X
20040 DATA4,DAWHOO RIVER,3.0,100,10,10,10,11,12,13,14,15,16,17,19,23,27,30,27,26,26,23,17,1
4,13,12,11,10,10,-820,-330,300,800,X
20050 DATA5,STONO RIVER,2.7,30,5,5,5,5,5,5,5,5,6,7,9,23,47,81,89,86,81,77,73,68,63,60,56,53
,47,-850,-350,350,740,X
20060 DATA6,STONO INLET,2.7,0,13,15,17,19,20,23,28,35,47,62,78,97,99,83,58,41,19,19,17,16,1
5,14,13,12,11,-930,-440,320,700,X
20070 DATA7,ASHLEY RIVER 10NW CHS,2.8,40,11,13,15,16,17,19,22,25,31,38,46,66,131,150,130,10
3,83,68,56,47,43,39,33,29,28,-840,-350,350,740,X
20080 DATA8,CHARLESTON HARBOR,2.6,0,13,15,17,19,20,23,28,35,46,62,83,112,127,116,82,44,26,1
9,18,18,17,17,16,15,14,-910,-410,320,720,X
20090 DATA9,HWY.41-WANDO RIVER,2.7,100,10,10,10,11,12,13,14,15,16,18,21,28,46,71,82,82,74,6
6,63,57,55,53,52,51,44,-850,-340,310,720,X
20100 DATA10,GOOSE CREEK-ENTRANCE,2.6,100,10,10,10,10,10,10,10,10,10,10,11,12,12,24,73,59,5
5,52,47,43,39,38,37,36,35,-830,-320,340,750,X
20110 DATA11,GEORGETOWN-WINYAH BAY,2.0,30,11,12,13,14,15,16,17,19,22,25,28,34,38,42,42,40,3
7,32,29,27,25,23,21,19,18,-720,99,99,530,X
20120 DATA12,MYRTLE BEACH,2.5,10,15,16,18,18,19,21,23,25,26,28,28,29,27,24,21,15,10,10,15,1
8,15,10,8,9,10,-650,99,99,600,X,999
```

APPENDIX A - Program Listing Comments

LINE (S)

860 Jump over line 900 to protect from accidental use
900 Cold restart for computer-used after running full-size printout
1000 Flag to indicate initial load and merge from disk
1050 If not initial load- go to Main Menu
1100 If not either- then jump over line 1200
1200 Get name of track from high memory-print prompt-merge track with main SLOSH1 program
1300 Clear high memory and reserve for machine-language routines
1400 reserve memory for high-resolution graphics
1500 Load Character generator file- flag that this is done
1600 Dimension variables
1700 Tell computer location of character generator program in memory
1800 Subroutine to call character generator program- A is location on graphics screen... A$ is character string to be printed
2000-2700 Main Menu- Variable C1 is your choice
2800-3800 Subroutine to set time of tides for day and arrival time of storm...routes back to Main Menu on completion
3900-5200 Subroutine to read data from data statements (lines 20010 through 20120) representing surge profiles for this track.
5300-5800 Subroutine to compute hourly tide values and adjust for tidal departures at different locations
5900-6900 Subroutine to compute hourly Tide + Surge for 25 hour period straddling time of arrival of storm- also scale chart to size which will include all data
7000-8400 Subroutine to print list of available locations for selection or if C1 from Main Menu is 4 or 5...to print list along with max surges for each location
8500 Initializes graphics parameters
8600-12200 Set up basic chart background, labels and legends on screen
12300-13445 Draw plot of storm surges and tides on graphics screen
13500-13800 When plotting finished...wait for key press..."M" to return to Main Menu..."P" to go to screen print routine
13900 Begin Screen Print subroutine
13920 Set Baud rate for CGP-220 Printer to 2400
13940-14100 Menu to set size of printout and prompt diskette switch if full-size printout is chosen
14120 Execute machine language program to printout full size
14140 Execute machine language program to printout half size plus return to graphics screen while printout in progress
20000 H$ = string identifying storm track in memory
20010-20120 Data Statements for 12 different locations. Each data statement line is divided up as follows:

* DATA - identifies line as data to be read into computer (from subroutine at line 3900)
* NUMBER - (1,2,3,etc.) - identifies location number
* NAME OF LOCATION - (Hilton Head,etc.)

* MEAN TIDAL RANGE (Above and below MSL) - Example 3.3 (feet)
* TIDE DEPARTURE (TIME) FROM KEY LOCATION - (Example -30 is 30 minutes before Charleston)
* 25 HOURLY SURGES - (in tenths of feet, Example 10 = 1.0 feet) representing surges each hour from 12 hours before arrival time of storm to 12 hours after.
* WIND THRESHOLDS (4 items) -
  - *Beginning of 40 Mile an hour winds
  - *Beginning of Hurricane force winds
  - *Ending of Hurricane force winds
  - *Ending of 40 mile an hour winds

Times are in hours and minutes before (-) or after arrival of storm-

Example- -810 is 8 hours, 10 min before landfall
630 is 6 hours, 30 min after landfall

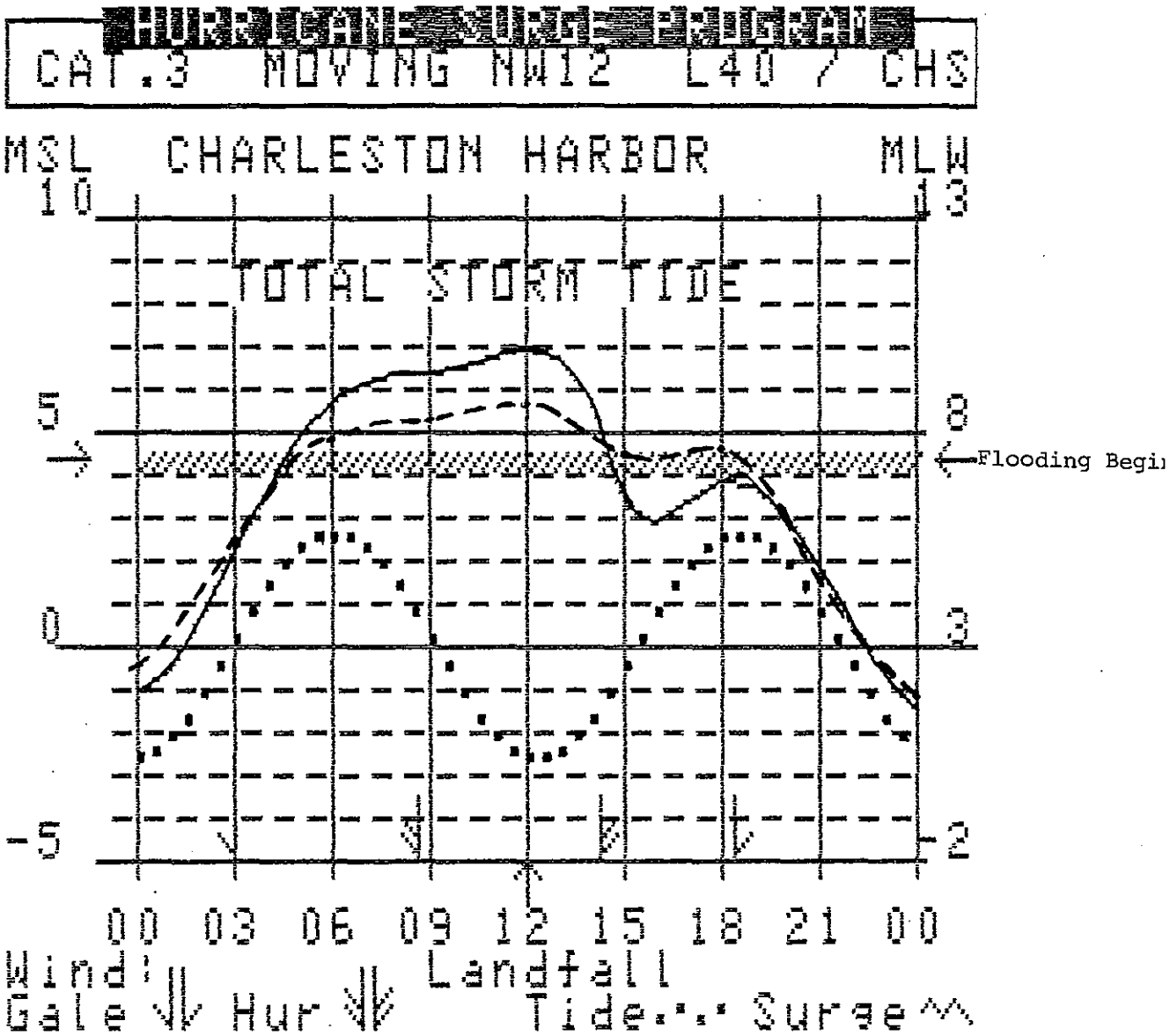
* END MARKER - "X" to identify end of statement

* (In last line only) END MARKER - "999" to identify end of all data statements

Note: All items in each data statement must be separated by a comma (except between word "data" and the first item in the series)

APPENDIX B - Computer Printouts

FIGURE 1.



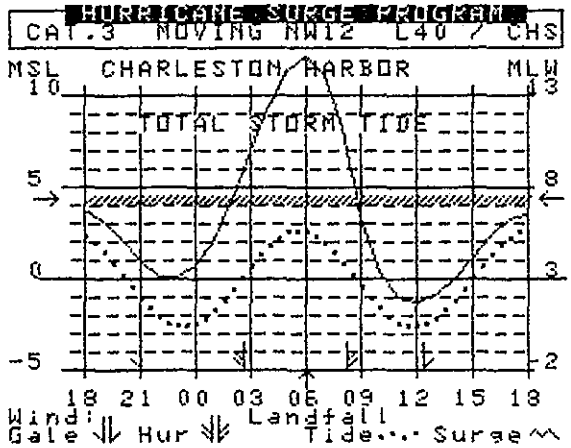


FIGURE 2

Figure 1 - (above)- Full size printout of SLOS storm tide forecast for Charleston Harbor usin a Cat. 3 storm moving northwest 12 mph. Landfall is St. Helena Sound area (40 left of CHS) The dashed line (added) is actual Hurricane Gracie tides in Charleston Harbor. Gracie was a Cat. 3 storm which struck 40 left of Charles ton with same landfall time and tides as those displayed.

Figure 2 -(left)-Half size printout of same storm as above, except landfall is 6 hours earlier, at time of high tide. This shows what Hurricane Gracie could have done, had it arrived 6 hours earlier. Computer calculatior allows all-important tide factor to be figured rapidly as storm arrival time changes.

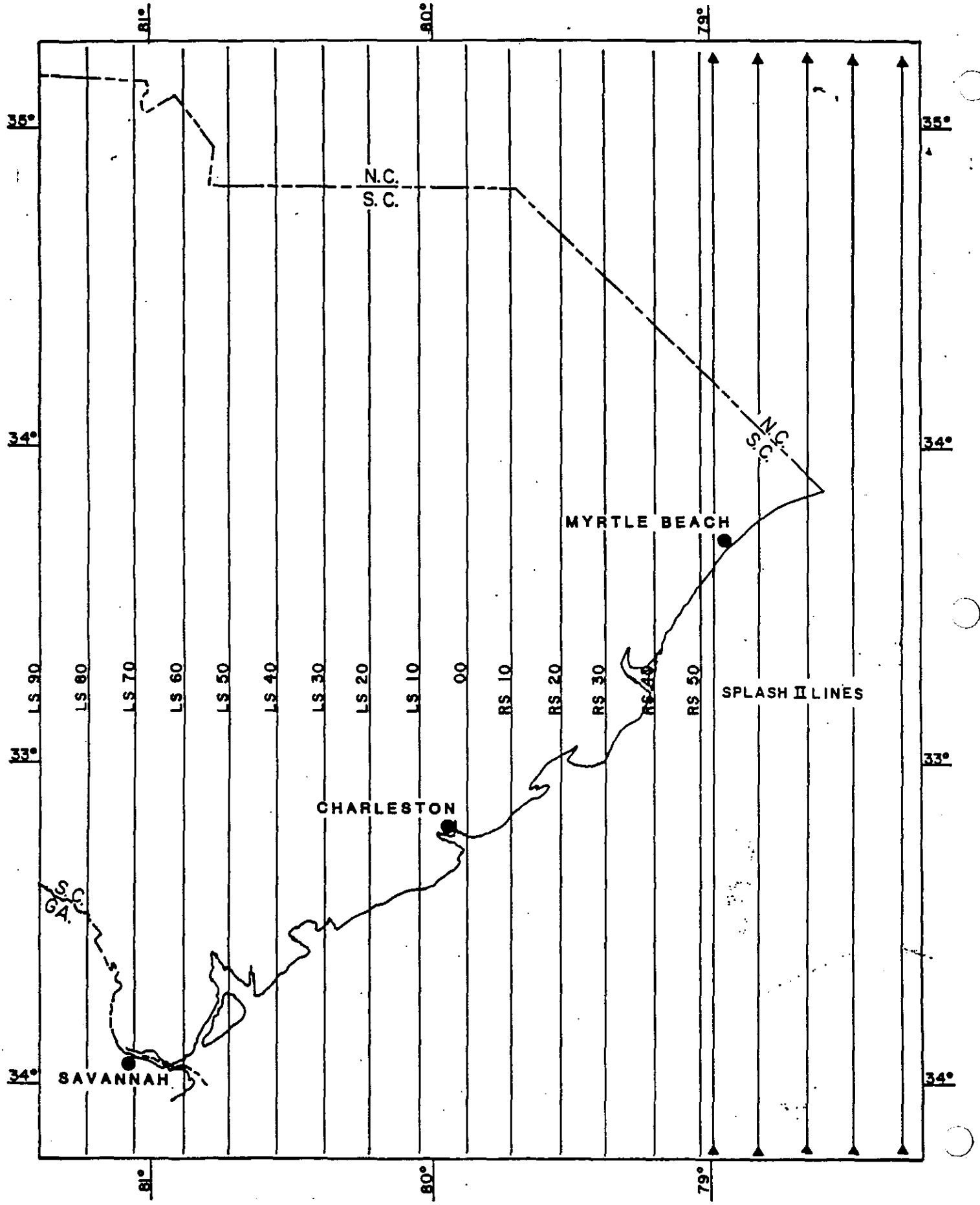


Figure 3 Tracks of Hurricanes Moving North.
(S.C. Water Resources Commission Maps)

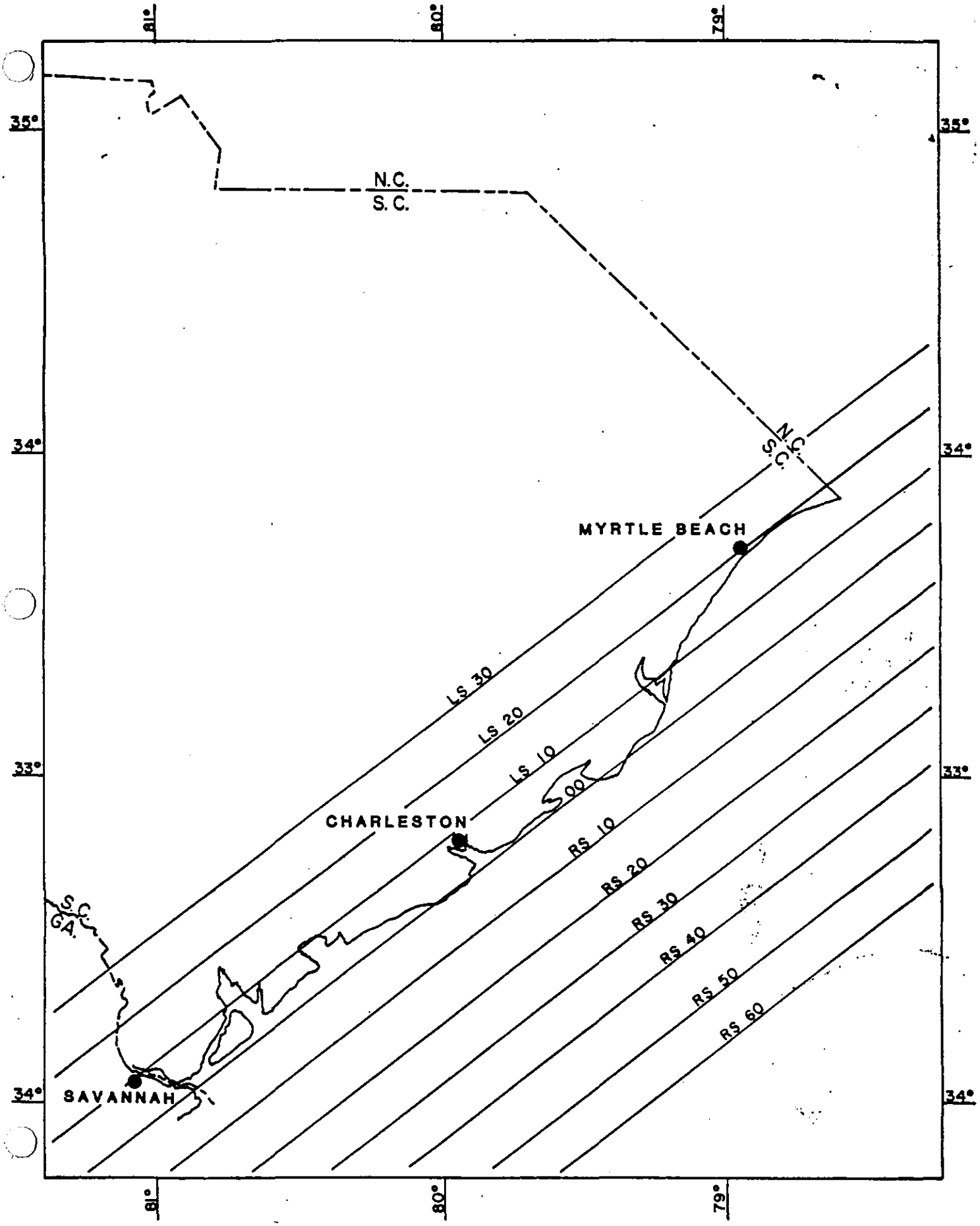


Figure 4 Tracks of Hurricanes Moving Northeast.

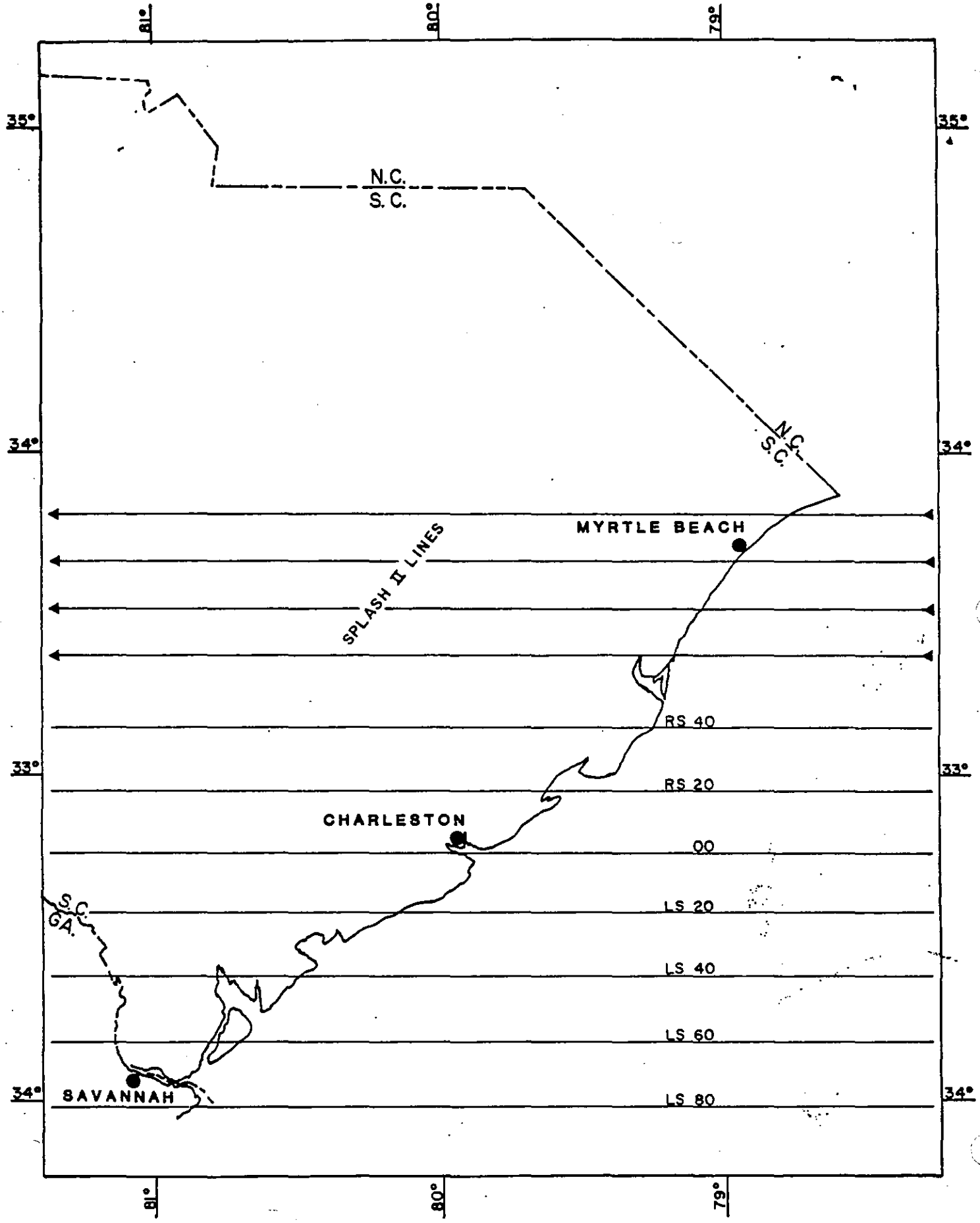


Figure 5 Tracks of Hurricanes Moving West.

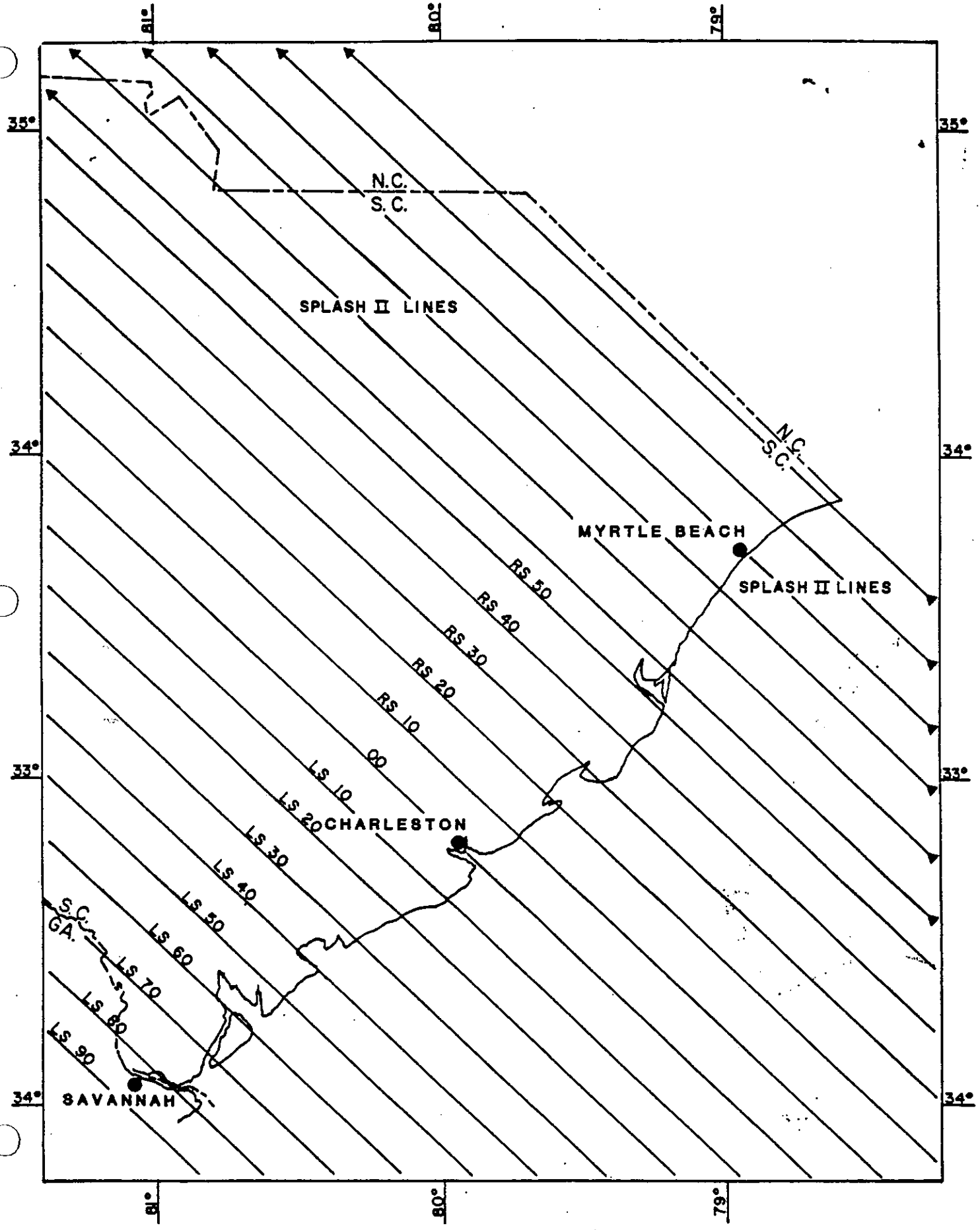


Figure 6 Tracks of Hurricanes Moving Northwest.