AFCRL-71-0115

AD722076

ANALYSIS OF STRATOSPHERIC BALLOON PROGRAMS

M. PATRICIA HAGAN

THE TRUSTEES OF EMMANUEL COLLEGE
400 THE FENWAY
BOSTON, MASSACHUSETTS 02115

Contract No. F19628-68-C-0065
Project No. 6665
Task No. 666506
Unit No. 66650601

FINAL REPORT

Period Covered: 1 January 1968 through 31 December 1970

Date of Report
31 March 1971

Contract Monitor: George F. Nolan
Aerospace Instrumentation Laboratory

Prepared
for

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS 01730

2

AFCRL-71-0115

ANALYSIS OF STRATOSPHERIC BALLOON PROGRAMS

M. PATRICIA HAGAN

THE TRUSTEES OF EMMANUEL COLLEGE
400 THE FENWAY
BOSTON, MASSACHUSETTS 02115

Contract No. F19628-68-C-0065

Project No. 6665

Task No. 666506

Unit No. 66650601

FINAL REPORT

Period Covered: 1 January 1968 through 31 December 1970

Date of Report
31 March 1971

Contract Monitor: George F. Nolan
Aerospace Instrumentation Laboratory

This document has been approved for public release and sale; its distribution is unlimited.

Prepared
for

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS 01730

ABSTRACT

The work under this contract has been computational and analytical services in support of operations analysis, applications research and post flight analysis of stratospheric scientific balloon programs conducted by the Air Force Cambridge Research Laboratories (AFCRL). Geophysical and flight data, furnished by the Government, were utilized for transcription, analysis, graphing, and mathematical computations. The work performed includes hand and machine plotting and the writing of several computer programs.

1. COMPUTER PROGRAMS AND COMPUTER RUNS

1.1 A printout of VHF Omnidirectional Range (VOR) data for approximately 60 stations using a program previously written at Emmanuel College was made. The program uses geographic and magnetic positions of receiving stations to calculate latitude and longitude crossings of any VOR signal received from a balloon. This work was accomplished in support of an in-house research effort to develop balloon locating systems that make use of existing navigational aids. The VOR network was utilized to provide position data.

1.2 Programs were written to reproduce and analyze a computer tape of Weather Bureau Aerological Network (WBAN) data for Kwajalein. Wind data for selected criteria were printed out using the computer program. These data provided meteorological input to feasibility studies for a Simulated Large Explosive Detonable Gas Experiment (SLEDGE) conducted for the Defense Atomic Support Agency (DASA) by AFCRL.

1.3 Several analyses were made using Rawinsonde tapes supplied by AFCRL. The tapes required much editing before analysis could be performed. Some of the analyzed data were plotted by an electronic plotter. This work provided a statistically valid wind data base to be used in balloon trajectory analyses for balloon programs conducted at the White Sands Missile Range. Feasibility studies and operational planning data were provided for Project 698AJ recovery tests, "Study of Atmospheric Aerosols" also under Project 698AJ, and the National Aeronautics and Space Administration (NASA) Cosmic Ray Ionization Spectrograph Program (CRISP).

1.4 Full printouts were made of data for balloon flights from the AFCRL launch sites at Chico, California and Holloman AFB, New Mexico after compilation and analysis. (See Section 4). This effort used a program previously written by Emmanuel College. Partial printouts of selected criteria were made for balloon reliability studies.

2. KEYPUNCHING

Various keypunching done included FORTRAN programs, meteorological information for Standard Atmospheric Tables, and balloon flight data.

3. ANALYSES AND PLOTTING

3.1 Wind data were extracted from microfilm and analyzed for an Advanced Research Projects Agency (ARPA) study.

3.2 Winter stratospheric winds at Chico and Holloman (7 years of data) were analyzed and plotted for use in flight operational planning.

3.3 Surface wind durations for world-wide geographic locations were analyzed.

3.4 Time-altitude, azimuth angle and elevation angle data were reduced and analyzed and trajectory plots made for in-house research studies on balloon station keeping concepts.

3.5 Wallops Island, Virginia, launch projections and trajectory dispersion patterns were computed in support of balloon operations conducted by AFCRL for the NASA and for VOR test flight planning.

3.6 Stratospheric wind statistics were computed for White Sands, Cape Kennedy and Point Mugu as input for general trajectory studies for Air Force high altitude balloon programs.

3.7 Vector analysis of 15-minute wind data for two balloon flights using azimuth angle and HDO were made for research studies of minimum wind field fine structure in the lower stratosphere.

3.8 Tracking analysis of two balloon flights consisted of checking and correcting, if necessary, VOR readings for station and position; determining approximate location of the balloon using triangulation; plotting position using VOR information; and comparing results with Federal Communications Commission (FCC) data. Radar data were also plotted. These data provided information on the accuracy of the VOR balloon navigational system.

3.9 Miscellaneous data for the Balloon Field Test Director Handbook were collected and prepared for compilation to assist the Field Test Director in carrying out balloon operations.

3.10 Balloon Behavior Study (See Section 6).

3.11 Wind Characteristics Study (See Section 5).

3.12 M-hour maximum computations were made from White Sands wind data for use in tethered balloon studies and operational planning.

3.13 Balloon gore length and crease distance for various types of balloons were computed for use in balloon design research.

3.14 Wind data at 10,000 feet for many parts of the world were used to plot m-hour maximum curves. These curves became part of a tethered balloon study for the Mid-Course Surveillance System (MSS) program.

4. INVENTORY LISTING OF FLIGHT DATA FOR POST FLIGHT ANALYSIS

4.1 Information was extracted from post flight summary forms.

4.2 Information was checked for consistency and accuracy with data in flight folders.

4.3 Data were punched on IBM cards for further processing using a program written at Emmanuel College.

4.4 Multiple copies of the full printout were made for balloon flights conducted at Holloman (1962-68) and Chico (1964-68).

4.5 Selected printouts were generated to analyze balloon performance.

5. WIND CHARACTERISTICS STUDY

5.1 Wind velocities were extracted from rocketsonde data (1959-67) for eight stations at three heights for all months. Data were interpolated and units converted. These data were used in long duration balloon trajectory studies at 110,000 ft, 120,000 ft, and 130,000 ft.

5.2 Statistical analysis of wind data for selected months were made for research studies of trajectory dispersion models.

5.3 Plotting of winds for several altitudes and locations at various times of the year was done on weather maps to determine optimum balloon flight scheduling.

5.4 Coefficients of variation for speed and direction were calculated for input into trajectory studies.

6. BALLOON BEHAVIOR STUDY - RESEARCH CONCERNING THE VERTICAL MOTION OF BALLOONS

6.1 Baracoder sheets were corrected and time-altitude data generated for 39 flights.

6.2 Standard Atmospheric Pressures for various altitudes were calculated from tables.

6.3 Temperatures were taken from WBAN charts.

6.4 Pressure vs temperature charts were plotted and corresponding temperatures from pre-flight radiosonde runs were determined.

6.5 All data were keypunched for analysis.

6.6 Three-point means for elapsed time, altitude, and temperature were calculated and plotted for smoothing purposes.

7. BALLOON FLIGHT SIMULATION PROGRAMS

General: There are four programs named respectively SIMBALL, BALLFLT, PARAFLIT, and MAGMED. All programs operate on input wind data tape (blocked CC-808 described below with blocked backup tape) to be mounted on tape 3.

Input parameters for all four programs are the same except as noted below under individual program description.

TOPALT, ISD, IED--(F10.0,2I4)

TOPALT--maximum altitude for simulation (feet); if negative indicates flight parameters are changing (see below).

ISD, IED--start date and end date for simulation (inclusive); first two digits are month, last two are day.

If TOPALT is negative, the following are expected:

New flight parameters (NAMELIST /ALTY/TIME,STOP).

New TITLE (13A6) for printed or graphic output.

Flight parameters:

TIME--Ascent rate (feet per minute) between (N-2) thousand feet and N-thousand feet goes into TIME(N/2000-1). Ascent rate is converted into time in minutes; alternatively, ascent rates less than 50 fpm are assumed to be time in minutes.

STOP--Float time (minutes) at N-thousand feet goes into STOP(N/2000-1).

Programs compute statistics and/or solve problems associated with balloon flights. Below are listed two of these with abbreviated description and idiosyncracies if any:

7.1 SIMBALL--Basic balloon flight simulator described above. Prepares CRT output with individual flights, statistical summaries, 50% and 90% probability ellipses.

Idiosyncracy: Calls PLOTID, use CRTPLT if needed.

7.2 MAGMED--Program to compute when balloon crosses point 86.4NM west of launch site.

Idiosyncracies: None.

Following are listings of these two aforementioned programs.

```
$ID    # 5079    CANTOR       SIMBALL              K-1
$SETUP 3         CC-808,NORING
$IBJOB
$IBFTC MAIN
      VR(A,B,C)=(A-B*C/FN)/(FN-1.0)
      VAR(A,B)=VR(A,B,B)
      DIMENSION CARD(80)
      DIMENSION EZ(2,217)
      DIMENSION TIME(99),STOP(99),ALT(99),VX(99),VY(99)
      NAMELIST /ALTY/TIME,STOP
      DIMENSION  TITLE(13),TTL(2)
      COMMON TITLE,TTL
      COMMON EX,EY,SUMX,SUMY,R,PSI,XA,XB,ISD,IED,VARX,VARY,NFLITE,FN
      DIMENSION TTT(2,361)
      EQUIVALENCE(TTT(1,362),EZ)
      DATA TIME,STOP/1.0,2.0,3.0,4.0,95*1.0,99*0.0/
      RAD=57.2957795
      IDATE=1300
      CALL PLOTID(1.0)
      CALL REREAD
      TEST1=1.0E7-1.0
1     READ(5,100)TOPALT,ISD,IED,IREW
      READ (99,1515)CARD
      WRITE(6,1516)CARD
1515  FORMAT(   80A1)
1516  FORMAT(1X,80A1)
      WRITE(99,114)ISD,IED
114   FORMAT(I4,4H TO   I4)
      READ(99,115)TTL
100   FORMAT(F10.0,2I4,I1)
      IF(ISD.LT.IDATE)REWIND 3
      IF(TOPALT.GT.0.0)GO TO 88
      IF(TOPALT.EQ.0.0)CALL ENDPLT
      READ(5,ALTY)
      READ(5,115)TITLE
115   FORMAT(13A6)
      DO 928 I=1,99
      IF(TIME(I).GT.50.0)TIME(I)=2000.0/TIME(I)
928   CONTINUE
      TOPALT=-TOPALT
      DO 929 I=1,99
      J=2000*(I+1)
929   WRITE(6,930)J,TIME(I),STOP(I)
930   FORMAT(I10,F10.3,F10.0)
      REWIND 3
88    NFLITE=0
      SUMX=0.0
      SUMY=0.0
      SUMXX=0.0
      SUMYY=0.0
      SUMXY=0.0
      IF(IDATE.EQ.ISD)GO TO 3
2     READ(3)SITE,IYR,IDATE,IHR,NALT,(ALT(I),VX(I),VY(I),I=1,NALT)
      IF(SITE.NE.TEST1)GO TO 996
      IDATE=1300
      GO TO 995
996   IF(IDATE.LT.ISD)GO TO 2
      IF(IDATE.LE.IED)GO TO 3
995   IF(NFLITE.GT.1)GO TO 4
      WRITE(6,101)ISD,IED
101   FORMAT(21HONO FLIGHT BETWEEN    I6,5H AND   I6)
```

```
      GO TO 1
  3   IF(ALT(NALT).LT.TOPALT)GO TO 2
C     WRITE(6,102)IDATE,IYR,(ALT(I),VX(I),VY(I),I=1,NALT)
 102  FORMAT(1H12I6/(6F20.6))
      NFLITE=NFLITE+1
      NMAX=TOPALT
      IVEC=1
      T=0.0
      S=0.0
      I=6000
 666  J=I/2000-1
      IVEC=INTERP(NALT,ALT,I-1000,IVEC)
      FF=I-1000
      T=T+FVECT(TIME,ALT,VX,IVEC,FF,J)
      S=S+FVECT(TIME,ALT,VY,IVEC,FF,J)
 10   FF=I
      IVEC=INTERP(NALT,ALT,I,IVEC)
      S=S+FVECT(STOP,ALT,VY,IVEC,FF,J)
      T=T+FVECT(STOP,ALT,VX,IVEC,FF,J)
      I=I+2000
      IF(I.LE.NMAX)GO TO 666
      T=T/60.0
      S=S/60.0
      EZ(1,NFLITE)=T
      EZ(2,NFLITE)=S
      SUMX=SUMX+T
      SUMY=SUMY+S
      SUMXX=SUMXX+T*T
      SUMYY=SUMYY+S*S
      SUMXY=SUMXY+T*S
      GO TO 2
  4   CONTINUE
      FN=NFLITE
      VARX=VAR(SUMXX,SUMX)
      VARY=VAR(SUMYY,SUMY)
      R=VR(SUMXY,SUMX,SUMY)
      PSI=0.5*ATAN2(R+R,VARX-VARY)*RAD
      XA=SQRT((VARX+VARY)**2-4.0*(VARX*VARY-R*R))
      XB=0.5*(VARX+VARY-XA)
      XA=0.5*(VARX+VARY+XA)
      XA=SQRT(XA)
      XB=SQRT(XB)
      R=R/SQRT(VARX*VARY)
      SUMX=SUMX/FN
      SUMY=SUMY/FN
      EZ(1,NFLITE+1)=0.0
      EZ(2,NFLITE+1)=0.0
      EZ(1,NFLITE+2)=SUMX
      EZ(2,NFLITE+2)=SUMY
      CALL PLOTR(EZ,TTT)
      GO TO 1
      END
$IBFTC PPP
      SUBROUTINE PLOTR (EZ,T)
      DIMENSION EZ(2,217),T(2,361)
      DIMENSION  TITLE(13),TTL(2)
      COMMON TITLE,TTL
      COMMON EX,EY,SUMX,SUMY,R,PSI,XA,XB,ISD,IED,VARX,VARY,NFLITE,FN
      DIMENSION GARB(6)
      DIMENSION EL(2,361)
      DATA BL/1H /
```

```
      CALL ELLIPS(EL,XA,XB)
      CALL ROT(PSI,SUMX,SUMY,EL,T,2,12)
      WRITE(6,115)T
      WRITE(6,115)EZ
      WRITE(6,117)SUMX,SUMY,R,PSI,XA,XB
117   FORMAT(//(1P12E10.2))
115   FORMAT(//(12F10.3))
      N=2*(NFLITE+362)
      III=1
      CALL SCALE(T,8.0,N,1,20.0,XMIN,DX)
      WRITE(6,116)NFLITE,XMIN,DX
116   FORMAT(1H0,I5,2F20.6)
      WRITE(6,116)III
      DO 1 I=1,13
      IF(TITLE(I).NE.BL)N=6*I
1     CONTINUE
      N=-N
      CALL FRAME(0.5,2.25)
      CALL AXIS(0.0,TITLE,N,6.0,0.0,XMIN,DX,20.0)
      III=III+1
      WRITE(6,116)III
      CALL AXIS(0.0,TTL,12,8.0,90.0,XMIN,DX,20.0)
      III=III+1
      WRITE(6,116)III
      CALL LINE(EZ,EZ(2,1),NFLITE,2,-1,4,XMIN,DX,XMIN,DX)
      III=III+1
      WRITE(6,116)III
      CALL LINE(EZ(1,NFLITE+1),EZ(2,NFLITE+1),2,2,0,0,XMIN,DX,XMIN,DX)
      III=III+1
      WRITE(6,116)III
      CALL LINE(T       ,T(2,1),361,2,0,0,XMIN,DX,XMIN,DX)
      III=III+1
      WRITE(6,116)III
      CALL LINE(T,T(2,1)       ,2,360,0,0,XMIN,DX,XMIN,DX)
      III=III+1
      WRITE(6,116)III
      CALL LINE(T(1,91),T(2,91),2,360,0,0,XMIN,DX,XMIN,DX)
      III=III+1
      WRITE(6,116)III
      CALL ROT(PSI,SUMX,SUMY,EL,T,1,18)
      III=III+1
      WRITE(6,116)III
      CALL LINE(T       ,T(2,1),361,2,0,0,XMIN,DX,XMIN,DX)
      III=III+1
      WRITE(6,116)III
      VARX=SQRT(VARX)
      VARY=SQRT(VARY)
      X=-XMIN/DX
      CALL PLOT(X,0,3)
      III=III+1
      WRITE(6,116)III
      CALL PLOT(X,8.0,2)
      III=III+1
      WRITE(6,116)III
      CALL PLOT(0,X,3)
      III=III+1
      WRITE(6,116)III
      CALL PLOT(8.0,X,2)
      III=III+1
      WRITE(6,116)III
      WRITE(99,127)
```

```
127   FORMAT(80X)
      WRITE(99,101)SUMX,SUMY
      READ(99,102)GARB
101   FORMAT(6HXBAR =  F7.2,2X,6HYBAR =  F7.2)
102   FORMAT(6A6)
      CALL PLOT(0,-1.0,-3)
      III=III+1
      WRITE(6,116)III
      CALL  SYMBOL(0.0,0.125,GARB,0,34)
      WRITE(99,103)VARX,VARY
103   FORMAT(9HSIGMA-X =  F7.2,2X,9HSIGMA-Y =  F7.2)
      CALL PLOT(0,-0.25,-3)
      III=III+1
      WRITE(6,116)III
      READ(99,102)GARB
      CALL  SYMBOL(0.0,0.125,GARB,0,34)
      WRITE(99,104)XA,XB
104   FORMAT(9HSIGMA-A =   F7.2,2X,9HSIGMA-B =   F7.2)
      CALL PLOT(0,-0.25,-3)
      III=III+1
      WRITE(6,116)III
      READ(99,102)GARB
      CALL  SYMBOL(0.0,0.125,GARB,0,34)
      CALL PLOT(0,-0.25,-3)
      III=III+1
      WRITE(6,116)III
      WRITE(99,105)R,PSI,NFLITE
105   FORMAT(3HR = F7.4,2X,5HPSI =  F5.1,2X,3HN =  I4,6H          )
      READ(99,102)GARB
      CALL  SYMBOL(0.0,0.125,GARB,0,34)
      RETURN
      END
$IBFTC ELL
      SUBROUTINE ELLIPS(E,A,B)
      DIMENSION E(2,361)
      RAD=3.14159265358 9/180.0
      DO 1  I=1,361
      X=FLOAT(I-1)*RAD
      E(1,I)=A*COS(X)
1     E(2,I)=B*SIN(X)
      RETURN
      END
$IBFTC RT
      SUBROUTINE ROT(THET,XO,YO,EL,T,S)
      DIMENSION EL(2,361),T(2,361)
      DIMENSION XMAT(2,2),X(2)
      RAD=3.14159265358 9/180.0
      TT=THET*RAD
      TT=-TT
      XMAT(1,1)=COS(TT)
      XMAT(1,2)=SIN(TT)
      XMAT(2,1)=-XMAT(1,2)
      XMAT(2,2)=XMAT(1,1)
      X(1)=XO
      X(2)=YO
      DO 1  J=1,361
      DO 1  I=1,2
      T(I,J)=X(I)
      DO 2  K=1,2
2     T(I,J)=T(I,J)+S*XMAT(I,K)*EL(K,J)
1     CONTINUE
```

```
          RETURN
          END
$IBFTC FV
          FUNCTION FVECT(T,A,X,I,P,K)
          DIMENSION T(9),A(9),X(9)
          TEMP=(X(I+1)-X(I))/(A(I+1)-A(I))*(P-A(I))+X(I)
          FVECT=TEMP*T(K)
          RETURN
          END
$IBFTC INTRP
          FUNCTION INTERP(N,A,I,J)
          DIMENSION A(99)
          IF(J.GT.N)J=N
          IF(J.LT.1)J=1
  2       K=A(J)
          IF(K.EQ.I)GO TO 1
          IF(K.GT.I)GO TO 3
          KK=A(J+1)
          IF(KK.GE.I)GO TO 1
          J=J+1
          GO TO 2
  3       IF(J.EQ.1)GO TO 1
          J=J-1
          GO TO 2
  1       INTERP=J
          RETURN
          END
$DATA
 10000.0   07010715
 $ALTY  TIME=99*800.0,  STOP=99* 0.0  $
  TO 10 K FT AT 800 FPM.  SCALES ARE NM
 10000.0   07160731
 10000.0   08010815
 10000.0   08160831
```

```
$ID    * 5079    CANTOR         MAGMED                    K-1
$SETUP 3         CC-808,NORING
$IBJOB
$IBFTC MAIN
       VR(A,B,C)=(A-B*C/FN)/(FN-1.0)
       VAR(A,B)=VR(A,B,B)
       DIMENSION CARD(80)
       DIMENSION EZ(2,217)
       DIMENSION TIME(99),STOP(99),ALT(99),VX(99),VY(99)
       NAMELIST /ALTY/TIME,STOP
       DIMENSION  TITLE(13),TTL(2)
       COMMON TITLE,TTL
       COMMON EX,EY,SUMX,SUMY,R,PSI,XA,XB,ISD,IED,VARX,VARY,NFLITE,FN
       DIMENSION TTT(2,361)
       EQUIVALENCE(TTT(1,362),EZ)
       DATA TIME,STOP/1.0,2.0,3.0,4.0,95*0.0,99*0.0/
       RAD=57.2957795
       DATA IXX,IBL,XMAX/1HX,1H ,-5184.0/
       IDATE=1300
       CALL REREAD
       TEST1=1.0E7-1.0
 1     READ(5,100)TOPALT,ISD,IED,IREW
 100   FORMAT(F10.0,2I4,I1)
       IF(ISD.LT.IDATE)REWIND 3
       IF(TOPALT.GT.0.0)GO TO 88
       READ(5,ALTY)
       READ(5,115)TITLE
 115   FORMAT(13A6)
       WRITE(6,1515)
       TMM=0.0
       DO 928 I=1,99
       IF(TIME(I).GT.50.0)TIME(I)=2000.0/TIME(I)
       TMM=TMM+TIME(I)
 928   CONTINUE
       TOPALT=-TOPALT
       DO 929 I=1,99
       J=2000*(I+1)
 929   WRITE(6,930)J,TIME(I),STOP(I)
 930   FORMAT(I10,F10.3,F10.0)
       WRITE(6,1515)TITLE
 1515  FORMAT(1H1,13A6/20HODATE     TIME      Y       )
       REWIND 3
 88    NFLITE=0
       IF(IDATE.EQ.ISD)GO TO 3
 2     READ(3)SITE,IYR,IDATE,IHR,NALT,(ALT(I),VX(I),VY(I),I=1,NALT)
       IF(SITE.NE.TEST1)GO TO 996
       IDATE=1300
       GO TO 995
 996   IF(IDATE.LT.ISD)GO TO 2
       IF(IDATE.LE.IED)GO TO 3
 995   IF(NFLITE.GT.1)GO TO 4
       WRITE(6,101)ISD,IED
 101   FORMAT(21HONO FLIGHT BETWEEN   I6,5H AND  I6)
       GO TO 1
 3     IF(ALT(NALT).LT.TOPALT)GO TO 2
C      WRITE(6,102)IDATE,IYR,(ALT(I),VX(I),VY(I),I=1,NALT)
 102   FORMAT(1H1216/(6F20.6))
       NFLITE=NFLITE+1
       NMAX=TOPALT
       IVEC=1
       T=0.0
```

```
      S=0.0
      I=6000
  666 J=I/2000-1
      IVEC=INTERP(NALT,ALT,I-1000,IVEC)
      FF=I-1000
      T=T+FVECT(TIME,ALT,VX,IVEC,FF,J)
      S=S+FVECT(TIME,ALT,VY,IVEC,FF,J)
      IOUT=IBL
      IF(T.GT.XMAX)GO TO 667
      IOUT=IXX
      GO TO 668
  667 CONTINUE
      I=I+2000
      IF(I.LE.NMAX)GO TO 666
      FF=TOPALT
      I=NMAX
      IVEC=INTERP(NALT,ALT,I,IVEC)
      X=FUNC(STOP,ALT,VX,IVEC,FF,J)
      STOP(J)=(XMAX-T)/X
      TMI=TMM+STOP(J)
      Y=S+FVECT(STOP,ALT,VY,IVEC,FF,J)
      Y=Y/60.0
      IF(X.GE.0.0)Y=TEST1
  668 CONTINUE
      IVEC=IVEC+1
      WRITE(6,114)IDATE,IYR,TMI,IOUT,Y
  114 FORMAT(   I5,I2,F7.1,A1,F7.1,5X,I8,2I3,1P7E13.3)
      STOP(J)=0.0
      GO TO 2
  4   CONTINUE
      GO TO  1
      END
$IBFTC FV
      FUNCTION FVECT(T,A,X,I,P,K)
      DIMENSION T(9),A(9),X(9)
      TEMP=(X(I+1)-X(I))/(A(I+1)-A(I))*(P-A(I))+X(I)
      FVECT=TEMP*T(K)
      RETURN
      END
$IBFTC INTTT
      FUNCTION FUNC(T,A,X,I,P,K)
      DIMENSION T(9),A(9),X(9)
      TEMP=(X(I+1)-X(I))/(A(I+1)-A(I))*(P-A(I))+X(I)
      FUNC=TEMP
      RETURN
      END
$IBFTC INTRP
      FUNCTION INTERP(N,A,I,J)
      DIMENSION A(99)
      IF(J.GT.N)J=N
      IF(J.LT.1)J=1
  2   K=A(J)
      IF(K.EQ.I)GO TO 1
      IF(K.GT.I)GO TO 3
      KK=A(J+1)
      IF(KK.GE.I)GO TO 1
      J=J+1
      GO TO 2
  3   IF(J.EQ.1)GO TO 1
      J=J-1
      GO TO 2
```

```
1     INTERP=J
      RETURN
      END
$DATA
 110000.0 07010831
 SALTY TIME=0.0,53*800.0 $
 800 FPM TO 110000 FT. PROFILE A
 110000.0 07010831
 SALTY TIME=0.0,23*800.0,30*600.0$
 800 FPM TO 50 K-FT. 600 FPM TO 110 K-FT.    PROFILE B
```

PROJECTS SUPPORTED UNDER THIS CONTRACT

1. Air Force
   - 6665
   - 8292
   - 698AJ (Recovery)
   - 698AJ (AOMP)

2. DASA - SLEDGE

3. NASA
   - Goddard - BAPE
   - MSC - CRISP
   - Langley - Viking

4. ARPA - 1366

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Emmanuel College Physics Research Division 400 The Fenway Boston, Massachusetts 02115	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

ANALYSIS OF STRATOSPHERIC BALLOON PROGRAMS

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Scientific. Final. 1 January 1968 - 31 December 1970

5. AUTHOR(S) (First name, middle initial, last name)

M. Patricia Hagan

6. REPORT DATE 31 March 1971	7a. TOTAL NO OF PAGES	7b. NO OF REFS 0
8a. CONTRACT OR GRANT NO F19628-68-C-0065 b. PROJECT, TASK, AND WORK UNIT NO. 6665-06-01 c. DOD ELEMENT 63404F d. DOD SUBELEMENT 636000	9a. ORIGINATOR'S REPORT NUMBER(S) 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) AFCRL-71-0115	

10. DISTRIBUTION STATEMENT

1- This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES TECH, OTHER	12. SPONSORING MILITARY ACTIVITY Air Force Cambridge Research Laboratories (LC) L. G. Hanscom Field Bedford, Massachusetts 01730

13. ABSTRACT

The work under this contract has been computational and analytical services in support of operations analysis, applications research and post flight analysis of stratospheric scientific balloon programs conducted by the Air Force Cambridge Research Laboratories (AFCRL). Geophysical and flight data, furnished by the Government, were utilized for transcription, analysis, graphing, and mathematical computations. The work performed includes hand and machine plotting and the writing of several computer programs.

DD FORM 1 NOV 65 1473

Unclassified
Security Classification

Unclassified
Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Balloon applications						
Atmospheric circulations						
Stratosphere						
Station-keeping vehicles						
Balloon design						
Balloon instrumentation						
Balloon trajectories						
Balloon post-flight analysis						

Unclassified
Security Classification