NATIONAL INSTITUTE OF OCEANOGRAPHY

WORMLEY, GODALMING, SURREY

NAVIGATIONAL PROGRAMS

N.I.O. INTERNAL REPORT No. N. 30

1973

NATIONAL INSTITUTE OF OCEANOGRAPHY

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N.I.O. PROGRAMS N.30

(Subroutines have negative numbers)

-46	Solution of inverse geodetic problem	SDANO
-68	Determine ship's position to E.S.N.W.	POSN
-135	Function to calculate height of geoid	GEOID
-136	Calculate end position of geodetic surface	GEODD
-175	Plot border of Mercator chart	MEGRJ
-177	Calculate latitude position on a Mercator chart	ALAT
-178	Convert map scales to standard form of inches/degrees longitude	CONSC
-179	Convert latitude to distance on Mercator Chart	AMERC
-183	Calculate longitude position on a Mercator chart	ALONG
-184	Annotate a Mercator chart	MEGRK
-206	Increment latitude and longitude	MATYN
-207	Calculate distance between two positions on an ellipsoidal earth	SPDST
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164	Master slave parameter calculation and storage	HNV1
252	Compute true wind speed from apparent wind and ship's velocity	BLOW
272	Calculation of position from hyperbolic fix	HYCAL

Queries regarding the use or availability of any of the programs in this volume may be made to:-

The Program Librarian,
Data Processing Group,
National Institute of Oceanography,
Wormley, Godalming, Surrey.

from whom a comprehensive list of all current N.I.O. Programs is available.

All the programs in this volume have been compiled and executed on an I.B.M. 1800 Computer having the following configuration:-

1802 Processor-controller with 32,768 words of core storage
3 1810 Disk Drives Model A
2 2401 Magnetic Tape Drives (30 Kc/s) (7 track)
1443 Printer, 240 lines/minute
1442 Model 6 Card Read-Punch
1816 Keyboard-Printer
Facit Paper Tape Reader, 1000 Characters/second
Facit Paper Tape Punch, 150 Characters/second

The Operating Systems were T.S.X. Version 3 or M.P.X. Version 3.

N.I.O. SUBPROGRAM -46

Title	Solution of Inverse Geodetic Problem.
Name	Subroutine SDANO
Machine	IBM 1800
Language	1800 Fortran IV
Purpose	Given the geographical co-ordinates of two points, SDANO will calculate the geodetic distance and azimaths between them

Use

Calling sequence:
```
  CALL SDANO (COD1, COD2, F, B, K, GEOD)
```
COD1 is a real four element array which must contain the following data,

COD1(1) : Eccentric latitude of first point,
COD2(2) : Longitude of first point,
COD3(3) : Sine of eccentric latitude,
COD4(4) : Cos of eccentric latitude.

COD2 is identical to COD1 except that it refers to the second point.

F = Spheroidal flattening,
B = Semi minor axis of spheroid
K = 0 if short geodesic is required,
    1 If long geodesic is required.

On return from the subroutine the three element array GEOD contains the following information.

GEOD(1) : Azimuth from point 1 to point 2,
GEOD(2) : Azimuth from point 2 to point 1,
GEOD(3) : Geodetic distance from point 1 to point 2.

All azimuths are measured clockwise from north. North latitudes and East longitudes are considered positive.

Subroutines Used

ATAN2.

Notes

This subroutines is based on the computational scheme contained in GIMRADA research note no. 11, "General Non-Iterative solution of the inverse and direct geodetic problems", by E.S. SODANO.

Programmer

M. Fasham.

N.I.O.SUBPROGRAM -68

Title Determine ship's position to E,N,S,W

Name POSN

Machine I.B.M.1800

Language 1800 Fortran IV

Purpose To determine whether the ship's position is North, South, East or West of 0^{o}, and return absolute latitude and longitude values to the calling program.

Calling Sequence CALL POSN (LAT,LATM,LONG,LONGM,LATV,LONGV)

where LAT is equal to the Inskel Common integer for latitude degrees.

LATM is equal to the Inskel Common integer for latitude 1/100 minute.

LONG is equal to the Inskel Common integer for Longitude degrees.

LONGM is equal to the Inskel Common integer for longitude 1/100 minute.

LATV is returned as "S" if latitude is negative, or "N" if latitude is positive.

LONGV is returned as "W" if logitude is negative, or "E" if longitude is positive.

Method If either LAT or LATM are negative, LATV is set to "S" and the absolute values of LAT and LATM are returned. If LAT and LATM are positive or zero, LATV is set to "N". If either LONG or LONGM are negative, LONGV is set to "W" and absolute values of LONG and LONGM are returned. If LONG or LONGM are positive or zero, LONGV is set to "E".

Restrictions.

The actual Inskel Common variables for latitude and longitude must not be used - they must be set to other variables to be used in the CALL. LATV and LONGV must be printed in A1 format in the calling program.

Programmer Eileen Page.

Title Function to calculate height of Geoid.

Name GEOID

Type Function S/R

Language Fortran

Operating System IBM 1800 TSX or MPX

Purpose To calculate the height in metres of the Geoid, at a given latitude and longitude, above the 1969 Smithsonian Earth (ref. 1)

Call HIGHT=GEOID(PLAT,PLON)
will place the geoidal height at latitude PLAT, longitude PLON in the variable HIGHT.
PLAT and PLON are given in degrees and fractions of a degree and the sign convention is + for North/East and - for South/West.
The calling program must contain the following DEFINE FILE statement:

```
DEFINE FILE 1(555,3,U,IREC)
```

and file 1 should be the data file SMITH containing the spherical harmonic data for the 1969 Smithsonian Earth.
(ref. Write Up of EARTH which places data on disk).

Restrictions The variables are extended precision.

Timing 5 seconds.

Method The earth's gravitational potential at P may be expressed as

$$\nu = \frac{GM}{r}\left(1 + \sum_{n=2}^{\infty}\sum_{m=2}^{n}\left(\frac{a}{r}\right)^{n} Y_{n,m}\right)$$

where G is the gravitational constant
M is the mass of the earth
r is the distance from P to the centre of the earth
$Y_{n,m}$ are spherical harmonics multiplied by constant coefficients.

Suppose now that ν is split up into ν_0, ν_1 with

$$\nu_0 = \frac{GM}{r}\left(1 - J_2 P_2 \left(\frac{a}{r}\right)^2 - J_4 P_4 \left(\frac{a}{r}\right)^4\right)$$

and ν_1 = all remaining terms
where
P_2, P_4 are zonal harmonics
a is the equatorial radius.
We may now define the reference ellipsoid (spheroid) as that for which $\nu_0 + \frac{1}{2}\Omega^2 r^2 \mathrm{SIN}^2 \phi$ is constant (i.e. equipotential for gravitational and rotational effects) over its surface.
Therefore it immediately follows that for a small variation δr along the normal to the surface the change in potential is

$$\frac{d}{dr}\left(\nu_0 + \frac{1}{2}\Omega^2 r^2 \mathrm{SIN}^2 d\right)\delta r$$

$$= \left\{-\frac{GM}{r^2}\left(1 - 3J_2P_2\left(\frac{a}{r}\right)^2 - 5J_4P_4\left(\frac{a}{r}\right)^4\right) + \Omega^2 r \,\mathrm{SIN}^2 \phi\right\}\delta r$$

therefore as the GEOID is defined as an equipotential surface for the total potential $\nu + \frac{1}{2}\Omega^2 r^2 \text{ SIN}^2\phi$ it follows that the above expression is equal to $-\nu_1$

$$\therefore \frac{\delta r}{a} = \frac{\nu_1}{(1-3J_2P_2-5J_4P_4+ \frac{\Omega^2 a^3}{GM}\text{SIN}^2\phi)}$$

where we have set r=a with sufficient accuracy.
For the 1969 Smithsonian earth the following constants are used for equatorial radius and flattening.

a = 6378155 metres
f = 1/298.255

The computational procedures are straightforward.
The following recurrence relations are used

$$\left.\begin{aligned} P_1^0 &= 1 \\ P_n^n &= (2n-1)\, P_{n-1}^{n-1} \cdot \text{COS}\,\theta \end{aligned}\right\} \text{for the sectional harmonics}$$

$$P_n^m = ((2n-1)\ \text{SIN}\theta\ P_{n-1}^m - (n+m-1)\ P_{n-2}^m)/(n-m)$$

for the other tesseral and zonal harmonics.
Values of a, f, and GM are read in from the first 3 records of the disk file followed by the coefficients of the cosine terms in the expansion (see below) of geopotential (up to $C_{22,22}$) followed by those of the sine terms.
The sine terms overlay the cosine ones to save space. The height is then calculated from the formular given above. The coefficients $C_{n,m}$, $S_{n,m}$ of the geopotential at the earth's surface occurs in the expansion as follows

$$\nu(\text{surface}) = \frac{GM}{a}\left(1 - \sum_{n=2}^{\infty}\sum_{m=0}^{n} P_n^m\ (C_{n,m}\ \text{COS}m\lambda + S_{n,m}\text{SIN}m\lambda)\right)$$

where λ is the longitude. The coefficients $C_{10}, S_{10}, C_{11}, S_{11}, C_{21}, S_{21}$ are zreo as are all $S_{n,0}$.

Programmer J.Crease

Date 25.3.71

Ref. Smithsonian Astrophysical Observatory Special Report No. 315

Title	Solution of direct Goedetic Problem
Name	GEODD Version 1
Machine	I.B.M. 1800
Language	Fortran IV
Purpose	Given a geodetic surface arc starting position, to calculate position of the other end.

Use

CALL GEODD (POS1,ARC,F,B,K,POS2)

The arguments have been chosen for compatibility with the subroutine SDANO. POS1 may be set up by using ECCL. POS1 (length 5) gives the first position, stored as:

(1) Eccentric Latitude (radians)
(2) Longitude
(3) Sine of (1)
(4) Cosine of (1)
(5) (True) Latitude

ARC (Length 3) contains
(1) Azimuth of arc at POS1
(3) Geodetic length of arc in metres

F is spheroidal flattening
B is semi-minor axis of sheroid
K is Ø if refinement of results is not required (in which case, POS1(5) is not used) and not Ø if refinement is required.

On Return

POS2 gives second point, stored as for POS1
ARC(2) is azmuth of arc to POS1 at POS2

Method

After E.M. Sodano, GIMRAD research note 11, pages 9-11 (N.I.O. Lib. ref. N 170.3/A/11)

Checks	None
Core size	958 words
Other routines used	ATAN2
Programmer	A. Voss

NATIONAL INSTITUTE OF OCEANOGRAPHY
DATA PROCESSING GROUP
LABORATORY PROGRAM DESCRIPTION

N.I.O. PROGRAM -175

Program Title: (For Lib. List)	Plot Border of Mercator Chart
Classification Letter:	N
Program Name:	MEGRJ
Version Number:	2Ø
Type of Program:	Subroutine
Operating System:	M.P.X.
Language:	FORTRAN IV
Programmer/Date:	Fasham/17.1.72
Program Passed By:	R. Wells
Description:	A common area of 516 words is required by this program
System Prerequisites:	
Inskel Common Variables:	
Subroutines Called:	AMERC
Programs Called:	
Files Called:	
Operation and Method:	

Calling sequence:-

CALL MEGRJ(WLONG,ELONG,SLAT,ANLAT,SCAL,II,INDEX)

where WLONG is longitude of left hand side of chart in degrees

ELONG is longitude of right hand side of chart in degrees

SLAT is latitude of bottom of chart in degrees

ANLAT is latitude of top of chart in degrees

SCAL is the scale of the chart in inches per degree longitude

II is an index that is non-zero if the border is to plotted

INDEX specifies the accuracy of the plotting of the latitudes on the chart. If INDEX equals zero the latitude increments will be constant over a degree square but will vary from one degree to the next. If INDEX equals one the latitude increments will be constant over the whole plotted chart. If INDEX equals two the latitude increments are calculated exactly using program AMERC and so this is the most accurate plotting method for Mercator charts.

Whatever the value of INDEX the same border will be plotted but if INDEX equals Ø or 1 then the subroutine will calculate meridional parts which are stored in the Common Area. The value of INDEX chosen in MEGRJ should also be used in subroutine MEGRK and ALATI.

The subroutine checks to see if the latitude difference specified by parameters SLAT, ANLAT is too large to be plotted, (i.e. greater than 29

inc hes) and if it is the subroutine returns with a value of -1 in II.
MEGRJ also defines the X and Y PLOTTER scale as 1 users unit per inch, and should be called once before using subroutine MEGRK or AIMP.

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DATA PROCESSING GROUP

LABORATORY PROGRAM DESCRIPTION

N.I.O. PROGRAM -177

Program Title: (For Lib. List)	Calculate latitude position on a Mercator Chart by three methods.
Classification Letter:	N
Program Name:	ALAT
Version Number:	2Ø
Type of Program:	Function Sub-program
Operating System:	M.P.X.
Language:	FORTRAN IV
Programmer/Date:	Fasham/20.1.72
Program Passed By:	R. Wells
Description:	
System Prerequisites:	A common area of 516 words is required by this program
Inskel Common Variables:	
Subroutines Called:	AMERC
Programs Called:	
Files Called:	
Operation and Method:	

Calling sequence:- Y=ALAT(XLAT,SLAT,ANLAT,SCAL,INDEX)

where XLAT is the latitude of the required point in degrees

SLAT is the latitude of the bottom of the chart in degrees

ANLAT is the latitude of the top of the chart in degrees

SCAL is the scale of the chart in inches per degree longitude

INDEX specifies the accuracy of the plotting of the latitudes on the chart. If INDEX equals zero the latitude increments will be constant over a degree square but will vary from one degree to the next. If INDEX equals one the latitude increments will be constant over the whole plotted chart irrespective of how many degree squares are contained in the chart. If INDEX equals two the latitude increments are calculated exactly using program AMERC as so this is the most accurate plotting method for Mercator Charts.

Y = distance in inches from the bottom of the chart to the position ALAT. Program MCGRJ must be called at least once before using ALAT (with the same value for INDEX).

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DATA PROCESSING GROUP
LABORATORY PROGRAM DESCRIPTION

N.I.O. PROGRAM -178

Program Title: (For Lib. List)	Convert Map Scales to standard form of inches per degree longitude.
Classification Letter:	N
Program Name:	CONSC
Version Number:	2Ø
Type of Program:	Function Sub-program
Operating System:	M.P.X.
Language:	FORTRAN IV
Programmer/Date:	Fasham/17.1.72
Program Passed By:	R. Wells

Description:

System Prerequisites:

Inskel Common Variables:

Subroutines Called:

Programs Called:

Files Called:

Operation and Method:

Calling sequence:-

SCAL=CONSC(INDEX,ALAT,AM)

where SCAL is scale in standard form of inches per degree longitude and if INDEX = Ø then scale to be converted is 1/AM at latitude ALAT, or if INDEX = 1 then scale to be converted is AM inches to one nautical mile at latitude ALAT.

The program uses the International Spheroid.

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DATA PROCESSING GROUP

LABORATORY PROGRAM DESCRIPTION

N.I.O. PROGRAM -179

Program Title: (For Lib. List) — Convert latitude to distance on a Mercator Scale.

Classification Letter: N

Program Name: AMERC

Version Number: 2Ø

Type of Program: Function Sub-program

Operating System: M.P.X.

Language: FORTRAN IV

Programmer/Date: Fasham/17.1.72

Program Passed By: R. Wells

Description:

System Prerequisites:

Inskel Common Variables:

Subroutines Called:

Programs Called:

Files Called:

Operation and Method:

Calling sequence:- Y=AMERC(ALAT,SLAT,SCAL)

where ALAT is the latitude of a given point in degrees

SLAT is the latitude of the bottom of the chart in degrees

SCAL is the scale of the chart in inches per degree longitude

Y is the perpendicular distance of the given point from the bottom of the chart in inches.

The formula used is the standard one for the Mercator Scale (see P.108 of Elements of Map Projections, U.S. Coast and Geodetic Survey special publication No. 68, 1921) ignoring powers higher than four. The spheroid used is the international spheroid.

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DATA PROCESSING GROUP

LABORATORY PROGRAM DESCRIPTION

N.I.O. PROGRAM -183

Program Title: (For Lib. List)	Calculate Longitude position on a Mercator Chart
Classification Letter:	N
Program Name:	ALONG
Version Number:	2Ø
Type of Program:	Function Sub-program
Operating System:	M.P.X.
Language:	FORTRAN IV
Programmer/Date:	Fasham/24.1.72
Program Passed By:	R. Wells
Description:	
System Prerequisites:	
Inskel Common Variables:	
Subroutines Called:	
Programs Called:	
Files Called:	
Operation and Method:	

Calling sequence:-

X = ALONG(ALON,WLONG,ELONG,SCAL)

where ALON is the longitude of the required point in degrees

WLONG is the longitude of the left hand side of the chart in degrees

ELONG is the longitude of the right hand side of the chart in degrees

SCAL is the scale of the chart in inches per degree longitude

X is the distance of the point from the left hand side of the chart in inches.

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DATA PROCESSING GROUP

LABORATORY PROGRAM DESCRIPTION

N.I.O. PROGRAM -184

Program Title: (For Lib. List)	Annotate Mercator Chart
Classification Letter:	N
Program Name:	MEGRK
Version Number:	2Ø
Type of Program:	Subroutine
Operating System:	M.P.X.
Language:	FORTRAN IV
Programmer/Date:	Fasham/20.1.72
Program Passed By:	R. Wells
Description:	
System Prerequisites:	A common area of 516 words is required by this subroutine.
Inskel Common Variables:	
Subroutines Called:	AMERC,ALAT,ALONG
Programs Called:	
Files Called:	
Operation and Method:	

Calling sequence:-

```
CALL MEGRK(IGRI,IMIN,WLONG,ELONG,SLAT,ANLAT,SCAL,INDEX)
```

where IGRI equals Ø for no internal grid
1 for internal grid every degree, latitudes only
2 for internal grid every degree, latitudes and longitudes

IMIN equals Ø for no minute marks on chart
1 for latitude minute marks only
2 for latitude and longitude minute marks

WLONG is the longitude of the left hand side of the chart in degrees

ELONG is the longitude of the right hand side of the chart in degrees

SLAT is the latitude of the bottom of the chart in degrees

ANLAT is the latitude of the top of the chart in degrees

SCALE is the scale of the chart in inches per degree longitude

INDEX specifies the accuracy of the plotting of the latitudes on the chart. If INDEX equals zero the latitude increments will be constant over a degree square but will vary from one degree square to the next. If INDEX equals one the latitude increments will be constant over the whole plotted chart irrespective of how many degrees squares are contained in the chart.

If INDEX equals two the latitude increments are calculated exactly using program MMARC and so this is the most accurate plotting method for Mercator Charts.

The latitudes and longitudes of the edge of the chart do not have to be whole numbers. However if either SLAT or ANLAT are not whole numbers then INDEX must take the value 1 or 2. The subroutine will annotate the degree ticks with the appropriate degree value. If there are no degree lines passing through the chart the subroutine will annotate the corners of the chart in degrees and minutes.
A plotter scale of one user unit per inch is assumed.

I.O.S. (WORMLEY)

DATA PROCESSING GROUP

LABORATORY PROGRAM DESCRIPTION

PROGRAM - 206

Program Title: (For Lib. List) Increment latitude and longitude (ellipsoidal earth)

Classification Letter: N

Program Name: MATYN

Version Number: 20

Type of Program: Nonprocess

Operating System: MPX

Language: FORTRAN

Programmer/date M.J. Fasham / 8.5.73

Program Passed By: T. Voss

Description: This S/R will calculate the new position of a ship given its old position and the ship's speed.

Operation:

The calling statement is:

CALL MATYN (PLAT, PLON, SLAT, SLON, KVNA, KVEA, KVNB, KVEB, Tim)

The input parameters to the subroutine are

PLAT, PLON Latitude and longitude, in minutes, at time t_1

KVNA, KVEA North and east components of ship's velocity, in hundredths of a knot, at time t_1

KVNB, KVEB North and east components of ship's velocity, in hundredths of a knot, at time t_2

Tim The time difference t_2-t_1 in tenths of a minute

The output parameters are

SLAT, SLON Latitude and longitude, in minutes, at time t_2

Method

The subroutine uses the following equations

$$DLAT = \frac{DISTN\,[\,1 + F\,(F-2).\,SIN^2\,\emptyset\,]^{3/2}}{A\,(1-F)^2}$$

$$DLON = \frac{DISTE\,[\,1 + F\,(F-2)\,\;SIN^2\,\emptyset\,]^{\frac{1}{2}}}{A\,Cos\,\emptyset}$$

Where

DISTN	is the distance travelled north since the last dead reckoning calculation
DISTE	is the distance travelled east
F	is the flattening coefficient of the reference ellipsoid.
A	is the semi-major axis of the reference ellipsoid.
ϕ	is the current ship's latitude.
DLAT, DLON	are the arc distances which we want to apply to the dead reckoning values.

The Fischer spheroiod is used as the reference ellipsoid in this routine. The above formulae are only accurate over distances of the order of tens of miles and so subroutine GEODD (N.I.O. - 136) should be used if more accurate geodetic calculations are required.

I.O.S (WORMLEY)

DATA PROCESSING GROUP

LABORATORY PROGRAM DESCRIPTION

PROGRAM - 207

Program Title : (For Lib. List)	Calculate distance between two positions on an ellipsoidal earth
Classification Letter:	N
Program Name:	SPDST
Version Number:	20
Type of Program:	Nonprocess
Operating System:	MPX
Language:	FORTRAN
Programmer/date:	M. Fasham / 8.5.73
Program Passed By:	T. Voss
Description:	This sub-routine will calculate the difference in nautical miles between two positions on an ellipsoidal earth

Operation:

The calling statement is:

```
CALL SPDST (PLAT, PLON, SLAT, SLON, DN, DE)
```

The input parameters are

PLAT, PLON   Latitude and longitude of first position in minutes (P_1)

SLAT, SLON   Latitude and longitude of second position in minutes (P_2)

The output parameters are

DN   The north component of the distance P_2-P_1 in nautical miles

DE   The east component of the same distance

Method: The equations used are the same as for subroutine MATYN (NIO - 206) These equations are only accurate over distances of the order of tens of miles and so subroutine SDANO (NIO - 46) should be used if more accurate geodetic calculations are required.

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DATA PROCESSING GROUP

LABORATORY PROGRAM DESCRIPTION

N.I.O. PROGRAM 160

Program Title: (For Lib. List)	Plot Data On A Mercator Chart.
Classification Letter:	N
Program Name:	TRPLA
Version Number:	2Ø
Type of Program:	Non-Process
Operating System:	M.P.X.
Language:	Fortran IV
Programmer/Date:	Fashan 24.1.72
Program Passed By:	C.Spackman
Description:	TRPLA can be used to plot track charts, fix charts and plots of observed variables from any standard ship file.
System Prerequisites:	
Inskel Common Variables:	
Subroutines Called:	DFT,DFTCH,CONSC,AMERC,ALAT,ALONG,MEGRJ,MEGRK,PLTSH,FXDEG, MEPLX,MECHA,NEAR,DECID,RAISE.
Programs Called:	TRPLB
Files Called:	Any Ship System File.

Operation and Method:

Input: The program should be stored in the fixed area and the following cards are required:

```
                      19   24
    //bJOB             X    X

    //bXEQbTRPLAbbbFX
```

followed by four or five parameter cards which will now be described:-

Card 1

e.column

1 - 6 Name of data file, left justified. (3A2 Format)

8 Drive number of disk containing data file. (I1 Format)

Card 2

c.column

1 - 5 Record number of first item of data that is to be plotted. (Right justified I5 Format)

6 - 10 Record number of last item of data that is to be plotted. (Right justified I5 Format)

Card 3

c.column

1 - 10 Longitude of left hand edge of chart in degrees and fractions. (Decimal format anywhere in field)

11 - 20 Longitude of right hand edge of chart in degrees and fractions. (Decimal format anywhere in field)

22 - 23 Chart identification parameter (ICHT). This can take the following values (I2 Format).

1 to 12 This means the data is to be plotted on standard one in a million Admiralty plotting sheets. These sheets are divided into 6 degree intervals and ICHT should be made equal to the North latitude of the plotting sheet divided by 6. For example the sheet containing latitudes 42° to 48° would have a value of ICHT of 8.

The other three possible values of ICHT specify that the scale of the chart is to typed on card 4 in one of three possible ways, namely

21 Scale specified in X inches per degree longitude.

22 Scale specified as 1/X at latitude ALAT.

23 Scale specified as X inches per nautical mile at latitude ALAT.

Card 4

c.column

1 - 10 Latitude of bottom of chart in degrees and fractions. (Decimal format anywhere in field)

11 - 20 Latitude of top of chart in degrees and fractions. (Decimal format anywhere in field)

21 - 30 Value X as specified in card 3. (Decimal format anywhere in field)

31 - 40 Value ALAT as specified in card 3 in degrees and fractions. (Decimal format anywhere in field)

Card 5

c.column

1 - 2 Chart type indicator. This can take the following values:-

-1 for a track chart.

0 for a fix position chart.

>6 for an observed variable chart. In this case it should take the value of the word number in the record that contains the desired variable. This must be greater than 6 as the first six positions contain the day, time and position of the observations.

4 IPLOT: This is equal to one if a border is to be plotted, zero if it is not.

6 This specifies the inside grid and should be set to Ø for no inside grid, 1 for latitude grid only and 2 for a latitude and longitude grid.

8 This specifies the minute annotation and should be set to Ø for no annotation, 1 for latitude minute marks only and 2 for latitude and longitude minute marks.

9 - 13 This specifies the size of the annotating characters in inches. (F5.2 Format)

Data File Requirements: The program can be used on any ship system dynamic data file (i.e. one containing a header record) that contains position. The first six words of each record in the file must contain this information in the following form:-

Word	Data
1	Day Number
2	Time in tenths of a minute
3	Latitude (degrees)
4	Latitude (hundredths of a minute)
5	Longitude (degrees)
6	Longitude (hundredths of a minute)

West longitudes and South latitudes should be negative numbers (both degrees and hundredths of a minute). Typical files that fulfil these requirements are :-

GEOF, SATF, HYPF.

Output:

1. Track charts. These are plotted as straight lines joining successive readings, but if there is a time gap of more than ten minutes the pen will be lifted before moving to the next position. A cross (+) is plotted on the track every hour and annotated in the form 1200/224 i.e. 12.00 on day 224.

2. Fix position charts. Each position is plotted using a cross (x) and annotated with time as shown above. File records having negative day numbers (i.e. rejected fixes) are plotted using an asterisk (*) and satellite fixes are plotted using a square (□).

3. Observed variable chart. The position of the variable is plotted using a cross and the value of the variable is printed alongside. Obviously only integers can be plotted using this program.

If the program finds records that are outside the boundaries of the specified map these will be ignored and successive records will be read until records are found that lie inside the map or the end of the file is reached.

Notes on Use:

1. A map can be built up by using data from different files for example GEOF1 and GEOF2 or GEOF and SATF, by simply repeating the program. After the first run IPLOT should be set to zero so that the border is not plotted again.

2. Fix position plots and track plots can be plotted on the same map as they are annotated on different sides of the track.

3. The record numbers on card 2 should always be specified as precisely as possible as this saves time. The record numbers on the file DATF and GEOF are given on the output to the 1816 and 1053 typewriters respectively.

4. Data from a GEOF file, for a given period, should only be plotted if the course update for that period has been carried

out. The last few records for a dumped GEOF file will sometimes c contain data that has not been updated; however this data will be repeated in the next sequential GEOF file and here it will be in updated form. Values of the last updated record for any dumped GEOF file can be found by inspecting the 1053 listings produced by program BLISS.

NATIONAL INSTITUTE OF OCEANOGRAPHY

DATA PROCESSING GROUP

LABORATORY PROGRAM DESCRIPTION

N.I.O. PROGRAM 164

Program Title: (For Lib. List)	Master-Slave Parameter Calculation and Storage Program.
Classification Letter:	N
Program Name:	HNV1
Version Number:	21
Type of Program:	Non-Process
Operating System:	MPX
Language:	1800 Fortran IV
Programmer/Date:	M. Fasham
Program Passed By:	M. Fasham
Description:	Given input data on a master-slave pair, HNV1 calculates certain geodetic values and stores them on file for later use by program HYCAL.
System Prerequisites:	
Inskel Common Variables:	
Subroutines Called:	SDANO, ECCL, SWC, GET, ATAN2
Programs Called:	
Files Called:	

Operation and Method: To execute the program use the following cards:-

```
//bJOB
//bXEQbHNV1
*FILES(4,HNMF,0)
*CCEND
```

Data Immediately follows *CCEND

1) N, NP

formatted (2I3) where:

N is the number of master-slave pairs to be read in.

NP is the record number on file HNMF at which the parameters of the first master-slave pair are to be stored. The following master-slave pair parameters are stored sequentially after this.

2) Each master-slave pair will require a card containing the following data:

Column	Data
1 - 3	Master-slave pair identification number (right justified)
5	Chain code = 1 for LORAN-C
	= 2 for LORAN-A
	= 3 for DECCA
	= 4 for HYFIX
	= 5 for OMEGA

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DATA PROCESSING GROUP

LABORATORY PROGRAM DESCRIPTION

N.I.O. PROGRAM 252

Program Title: (For Lib. List)	Compute true wind from apparent wind and ship's velocity.
Classification Letter:	N
Program Name:	BLOW
Version Number:	20
Type of Program:	Non-Process
Operating System:	M.P.X.
Language:	Fortran
Programmer/date:	E.G. Pitt/ 17.12.71
Program Passed By:	
Description.	Computes true wind from apparent wind and ship's course and speed.
System Prerequisites:	
Inskel Common Variables:	
Subroutines Called:	ATAN2, IPUT, IFIX
Programs Called:	
Files Called:	

Operation and Method:

Uses vector identity $\bar{V}_T^1 = \bar{V}_a - \bar{V}_s$ (1) where

$\bar{V}r$ is true wind as normally defined *

$\bar{V}a$ is apparent wind as normally defined *

$\bar{V}s$ is ship's velocity (course and speed) as normally defined +

Program first refers apparent wind direction to true North, (i.e. adds direction to ship's course), takes the two component equations (easting and northing) of (1) to get the components of V_T, then uses ATAN2 to obtain the direction, and $\sqrt{V_{T_N}^2 + V_{T_E}^2}$ for speed.

*Direction is point from which wind blows.

+Direction is point to which ship is headed

Inputs: Program deck followed by // XEQ BLOW

*CCEND

Data Cards

cols 1 sp.

2-4 relative wind direction (I3)

5 sp.

6,7 relative wind speed (I2)

8 sp.

9-11 ship's course (I3)

12 sp.

13,14 ship's speed (I2)

20-23 hour (I4)

24 sp.

25,26 day (I2)

27 sp.

28,29 month (I2)

30 sp.

31,32 year (I2)

End Card 99 is punched in cols. 34,35 of the last data card.

99 is the stop code (designated ISTOP in the program).

NATIONAL INSTITUTE OF OCEANOGRAPHY
DATA PROCESSING GROUP
LABORATORY PROGRAM DESCRIPTION

N.I.O. PROGRAM 272

Program Title: (For Lib. List)	Calculation of position from a hyperbolic fix
Classification Letter:	N
Program Name:	HYCAL
Version Number:	20
Type of Program:	Non-Process
Operating System:	M.P.X.
Language:	FORTRAN IV
Programmer/Date	M. Fasham
Program Passed By:	M. Fasham
Description:	HYCAL will calculate the latitude and longitude of LORAN/DECCA, OMEGA or HYFIX fixes.
System Prerequisites:	
Inskel Common Variables:	
Subroutines Called:	ECCL, SDANO, SWC, HYPB, ATAN2, FULL
Programs Called:	
Files Called:	HNMF, FIXF (or any fix file similaraly defined). HNMF contains the master-slave pair data, which is loaded using program HNV1 (N.I.O. Program 164).

Operation and Method:

Job Description:-

```
                19   24
//ƀJOB           X    X
//ƀXEQƀHYCAL
*FILES(4,HNMF,F)
*FILES(11,FIXF,F)
*CCEND
```

where F is the drive number of the HNMF and FIXF files.

Input:- The following cards are required:-

(i) Job title card - any alphanumeric data 80 columns

(ii) c.c. 1 - 2 number of blocks of data. A block is defined below.
c.c. 4 set to 1 if the calculated fixes are to be stored in the FIXF file, otherwise leave blank. The layout of the FIXF file is given in the M.P.X. ship system description.

(iii) Each block of data must be headed by the following card.
c.c. 1 - 3 If the fixes to be calculated have been punched on separate cards (option a,b), these columns should contain the number of fixes, right justified. If the fixes to be calculated are defined on one card (option c), these columns should contain any

negative number.

c.c. 5 - 6 code number of first master-slave pair. The code numbers are given in appendix 2.

c.c. 8 - 9 code number of second master-slave pair.

c.c. 12-25 contain a position that is used by the program as an approximation to begin the iterative calculation. It should be within a degree of the position of the first hyperbolic fix in the data block. Successive fixes in the block will use the previously calculated fix as a starting approximation. The format is as follows:-

c.c. 12-13 Latitude (degrees)

c.c. 15-16 Latitude (minutes)

c.c. 17 Alphanumeric N or S for north or south

c.c. 19-21 Longitude (degrees)

c.c. 23-24 Longitude (minutes)

c.c. 25 Alphanumeric W or E for west or east

(iv) There are three possible formats for entering fixes. The first two are used when fixes are typed one per card and the last is used if the fixes to be calculated are defined on one card.

(a) LORAN, HYFIX or OMEGA fixes.

c.c. 1 - 3 Day number of fix

c.c. 5 - 8 Time of fix in format HHMM

c.c. 9 -16 Reading in lanes or microseconds of first master-slave pair (decimal number anywhere in field)

c.c. 17-32 Reading in lanes or microseconds of second master-slave pair.

(b) DECCA fixes

c.c. 1 - 3 Day number of fix

c.c. 5 - 8 Time of fix in format HHMM

c.c. 10 Ambiguity of first DECCA reading (see note below for definition)

c.c. 11 Zone letter of first DECCA reading

c.c. 12-16 Lane count of first DECCA reading (decimal number anywhere in field)

c.c. 18 Ambiguity of second DECCA reading

c.c. 19 Zone letter of second DECCA reading

c.c. 20-24 Lane count of second DECCA reading

In most DECCA chains there is an ambiguity in the zone letter in that the A-J sequence is repeated twice in going from the master to the slave. The ambiguity should therefore be set to Ø or 1 depending on whether the reading in question is in the first or second A-J sequence. It is often necessary to consult a large scale map to decide this and it should be remembered that the zone count starts at the master station.

(c) It is often required to calculate a run of fixes in which each reading is separated by a constant increment and this is catered for by the third option.

c.c.	1 -10	Initial reading for master-slave pair 1
c.c.	11-20	Final " " " " " 1
c.c.	21-30	Increment value " " " " 1
c.c.	31-40	Initial reading for master-slave pair 2
c.c.	41-50	Final " " " " " 2
c.c.	51-60	Increment value " " " " 2

These readings should all be entered in lanes or microseconds as a decimal number anywhere in the field. No provision is made under this option for entering DECCA zone letters and so all DECCA readings should be converted to total lane counts using the table in appendix 2. However the readings are converted to zones and lanes when the calculated fixes are printed out.

Output:-

At the head of each block the master-slave pairs being used and the initial approximate position are printed. For each fix the day, time, readings and calculated position are printed. If option (c) has been specified the day and time are printed as zero for all fixes.

Error Messages:-

(i) An illegal DECCA zone has been entered for Day DDD, Time HHMM. A zone letter other than A-J has been used.

(ii) Fix Calculation Not Convergent

This means that the iterative calculation used to calculate the position has not converged after ten iterations. This could be due to specifying any master-slave pair number, or the initial approximate position, incorrectly. It could also be caused by too large a change in the readings of successive fixes. If this is tha case a new data block should be started thus enabling a new approximate position to be entered.

Method:-

The method is an adaption of that described in U.S. NAVAL OCEANOGRAPHIC OFFICE INFORMAL MANUSCRIPT REPORT NO. N-3-64, "LORAN to geographic conversion and geographic to LORAN conversion" by A.C. CAMPBELL. The method for a hyperbolic system with separate masters is used for all cases.

Ammendment to Program HYCAL N.I.O. PROGRAM 272

Please insert the following on Page 4 after line 6 before the table:-

Chain code	LORAN-C	T=1
	LORAN-A	T=2
	DECCA	T=3
	HYFIX	T=4
	OMEGA	T=5

T is negative for Fischer Spheroid

T is positive for International Spheroid.

APPENDIX ONE HYPERBOLIC CHAIN DATA

The information is the printed output from program HNV1. Other chains are added from time to time and the list shows the position on 8th Feb. 1973.

This information is kept in the Services room within the Data Processing Group, this is to make sure no numbers are duplicated by users.

NO	T	NAME
1	2	1L6
2	2	1L7
3	2	1S-5
4	2	1S-6
5	2	1S-7
6	-1	SL3-W
7	-1	SL3-X
8	-1	SL3-Y
9	-1	SL3-Z
10	-1	SL7-W
11	-1	SL7-X
12	-1	SL7-Z
13	-1	SL4-X
14	-1	SL4-Y
15	-1	SL4-Z
16	3	ENGLISH RD
17	3	ENGLISH GN
18	3	ENGLISH PL
19	3	N.BRIT.RED
20	3	N.BRIT.GRN
21	3	N.BRIT.PUR
22	3	SW.BRIT RD
23	3	SW.BRIT GN
24	3	SW.BRIT PR
25	3	N.SCOT. RD
26	3	N.SCOT.GRN
27	3	N.SCOT.PUR
28	3	FRENCH RD
29	3	FRENCH GRN
30	3	FRENCH PUR
31	3	NW.SPAN RD
32	3	NW.SPAN GN
33	3	NW.SPAN PR
34	4	CARDIFF P1
35	4	CARDIFF P2
36	4	THAMES P1
37	4	THAMES P2
38	-5	A-B
39	-5	A-C
40	-5	A-D
41	-5	B-C
42	-5	B-D
43	-5	C-D
44	-1	SS7-W
45	-1	SS7-X
46	-1	SS7-Y
47	-1	SS7-Z

Next available record space = 48

Appendix 2 Decca Zones, Letters and Numbers

No. of Decca Lane	Red	Green	Purple
0	A 0	A 30	A 50
10	A 10	A 40	A 60
18		B 30	
20	A 20	B 32	A 70
24	B 0		
30	B 6	B 42	B 50
36		C 30	
40	B 16	C 34	B 60
48	C 0		
50	C 2	C 44	B 70
54		D 30	
60	C 12	D 36	C 50
70	C 22	D 46	C 60
72	D 0	E 30	
80	D 8	E 38	C 70
90	D 18	F 30	D 50
96	E 0		
100	E 4	F 40	D 60
108		G 30	
110	E 14	G 32	D 70
120	F 0	G 42	E 50
126		H 30	
130	F 10	H 34	E 60
140	F 20	H 44	E 70
144	G 0	I 30	
150	G 6	I 36	F 50
160	G 16	I 46	F 60
162		J 30	
168	H 0		
170	H 2	J 38	F 70
180	H 12	A 30	G 50
190	H 22	A 40	G 60
192	I 0		
198		B 30	
200	I 8	B 32	G 70
210	I 18	B 42	H 50
216	J 0	C 30	
220	J 4	C 34	H 60
230	J 14	C 44	H 70
234		D 30	

240	A 0	D 36	I 50
250	A 10	D 46	I 60
252		E 30	
260	A 20	E 38	I 70
264	B 0		
270	B 6	F 30	J 50
280	B 16	F 40	J 60
288	C 0	G 30	
290	C 2	G 32	J 70
300	C 12	G 42	A 50
306		H 30	
310	C 22	H 34	A 60
312	D 0		
320	D 8	H 44	A 70
324		I 30	
330	D 18	I 36	B 50
336	E 0		
340	E 4	I 46	B 60
342		J 30	
350	E 14	J 38	B 70
360	F 0	A 30	C 50
Lanes Per zone	24	18	30
Master	A 0	A 30	A 50

Zones (all colours) lettered A,B,C,D,E,F,G,H,I,J; then repeat A,B etc.