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The main runs and datasets of the Fine Resolution Antarctic Model Project (FRAM) Part II: The fine resolution runs

B A de Cuevas

1993

Natural Environment Research Council

INSTITUTE OF OCEANOGRAPHIC SCIENCES
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Wormley
Godalming
Surrey GU8 5UB UK
Tel +44-(0)428 684141
Telex 858833 OCEANS G
Telefax +44-(0)428 683066

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ABSTRACT

The Fine Resolution Antarctic Model Project (FRAM) is an NERC Community Project which forms part of the UK contribution to the World Ocean Circulation Experiment (WOCE).

The fine resolution, primitive equation model of the Southern Ocean was run for a total of 16 years of simulation. Output was stored at regular intervals throughout the run and is available for analysis.

This document describes the main features of the model initialization as well as changes made during the run. Details are given of the files needed to run the model and process the output. The storage of the model output on tape is listed.

KEYWORDS

NUMERICAL MODELLING
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ISSUING ORGANISATION

Institute of Oceanographic Sciences
Deacon Laboratory
Wormley, Godalming
Surrey GU8 5UB. UK.

Director: Colin Summerhayes DSc

Telephone Wormley (0428) 684141
Telex 858833 OCEANS G.
Facsimile (0428) 683066

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CONTENTS

1. INTRODUCTION

The Fine Resolution Antarctic Model Project (FRAM) is an NERC Community Research Project designed to set up, run and analyse the results of a fine resolution primitive equation model of the Southern Ocean. Preliminary tests were made using a coarse (1° x 1°) resolution model, described in Part I of this document (de Cuevas, 1992). The fine resolution model was designed to cover the same domain, with the same 32 vertical levels. A horizontal grid of 1/4° in latitude by 1/2° in longitude was chosen, giving equal resolution at 60°S.

2. DESCRIPTION OF THE FINE RESOLUTION MODEL

The numerical model used is that described by Cox (1984). The model variables of potential temperature[1](T), salinity (S), two components of horizontal velocity (u,v), vertical velocity (w) and the stream function (ψ), are defined using an Arakawa B grid (Arakawa & Lamb 1977). Temperature, salinity and stream function are defined at the centres of the boxes and the horizontal vector velocity defined at the mid-points of the vertical edges. Vertical velocity is defined at the mid-points of the horizontal edges. The horizontal and vertical grids are illustrated below.

Table 1

(a) Horizontal grid spacing

```
              |                        |                       |
----U(I-1,J+1)--------------U(I,J+1)-------------U(I+1,J+1)---
              |                        |                       |
              |                        |                       |
              |       T(I,J+1)         |     T(I+1,J+1)        |
              |                        |                       |
              |                        |                       |
----U(I-1,J)----------------U(I,J)---------------U(I+1,J)-----
              |                        |                       |
              |                        |                       |
              |        T(I,J)          |      T(I+1,J)         |
              |                        |                       |
              |                        |                       |
----U(I-1,J-1)--------------U(I,J-1)-------------U(I+1,J-1)----
              |                        |                       |
```

1. In the remainder of this document, unless otherwise stated, temperature refers to potential temperature at a pressure of one atmosphere.

(b) Vertical grid spacing

```
        |                             |
----    | --------W(K)---------       |    ----
        |                             |
        |                             |
        |            T(K)             |
        |                             |
        |                             |
----    | -------W(K+1)--------       |    ----
        |                             |
        |                             |
        |           T(K+1)            |
        |                             |
        |                             |
----    | -------W(K+2)--------       |    ----
        |                             |
```

2.1 Model grid

The grid is defined in the model by:

IMT	=	722	(total number of T grid boxes zonally)
JMT	=	221	(total number of T grid boxes meridionally)
KM	=	32	(total number of vertical levels)
DXT	=	0.5	(zonal grid spacing across T boxes)
DYT	=	0.25	(meridional grid spacing across T boxes)

The southern boundary, defined in the model by SWLDEG = -79.0, refers to the latitude of the first interior (J = 1) row of velocity points. The latitude of the first interior row of temperature points is at 79.125°S. The northern boundary, defined by the latitude of the last interior (J = JMT) row of velocity points, is at 24.0°S. The last interior row of temperature points is at 24.125°S. Cyclic conditions are applied in the east-west direction. Temperature points for I = 2 and I = 362 correspond to 0° longitude.

The model variables defining depth are:

DZ	=	grid box thickness across u,v,T boxes
ZDZ	=	depth of bottom of boxes
ZDZZ	=	depth of centre of u,v,T boxes (except for the bottom box).

The vertical spacing (in metres) is given in the following table:

Table 2

Level	DZ	ZDZ	ZDZZ
1	20.7	20.7	10.35
2	23.3	44.0	32.35
3	26.5	70.5	57.25
4	31.0	101.5	86.00
5	37.3	138.8	120.15
6	46.7	185.5	162.15
7	61.6	247.1	216.30
8	85.9	333.0	290.05
9	121.0	454.0	393.50
10	156.0	610.0	532.00
11	180.0	790.0	700.00
12	195.0	985.0	887.50
13	205.0	1190.0	1087.50
14	211.0	1401.0	1295.50
15	215.0	1616.0	1508.50
16	219.0	1835.0	1725.50
17	221.0	2056.0	1945.50
18	223.0	2279.0	2167.50
19	225.0	2504.0	2391.50
20	226.0	2730.0	2617.50
21	227.0	2957.0	2843.50
22	228.0	3185.0	3071.00
23	229.0	3414.0	3299.50
24	230.0	3644.0	3529.00
25	230.0	3874.0	3759.00
26	231.0	4105.0	3989.50
27	231.0	4336.0	4220.50
28	232.0	4568.0	4452.00
29	232.0	4800.0	4684.00
30	233.0	5033.0	4916.50
31	233.0	5266.0	5149.50
32	233.0	5499.0	5382.50
33			5499.00

2.2 Topography

The model uses a smoothed version of the 1° x 1° topography developed for the coarse model from the DBDB5 depth dataset of the US Naval Oceanographic Office. The decision to use such a coarse topography was made because of the instability problems which developed in the initial spin-up of the coarse resolution model, when changes in topography between adjacent grid boxes were too great (Killworth 1987). With hindsight, this was probably over cautious.

2.3 Open boundary

The open boundary condition is that used in the coarse resolution model (Stevens 1991).

2.4 Equation of state

The Eckart (1958) equation of state was used for the main run of the fine resolution model and the EOS80 international equation of state for the sea ice run (Webb 1992).

2.5 Initial conditions

The model was initialised from rest with specified values of temperature (-2.0°C) and salinity (36.69 parts per thousand). No wind field was applied initially. Linear bottom friction was applied of form:

$\mathbf{F} = -CD * \mathbf{U}$ (coefficient CD = 0.1 in cgs units).

2.6 Input data

The input data file, fortran unit 5, contains several NAMELIST data files defining the model. Variable NMIX determines the frequency at which the Euler backward scheme is used for a forward timestep. The remaining variables in CONTRL concern the length of run and frequency of output. The horizontal and vertical mixing coefficients are given by the variables in EDDY, where AH, AM are the horizontal viscosity coefficients for tracers and momentum and FKPHF, FKPMF are the vertical diffusion coefficients for tracers and momentum respectively. The timestep is given by the variable DTTS. The variable SORF gives the coefficient of over-relaxation used in calculating the stream function, while CRITF is the convergence criterion and MXSCAN is the maximum number of scans allowed in the relaxation.

The full file contains:

```
&CONTRL    NFIRST = 1, NLAST =   72, NNERGY = 24, NMIX = 24,
           NWRITE = 99999, NDW=5, NTSI=1, NA=0, NB=0, NC=0, &END
&EDDY      AMF = 2.E6, AHF = 1.E6, FKPMF = 1., FKPHF = 0.5, &END
&TSTEPS    DTTSF = 1200, DTUVF = 1200, DTSFF = 1200, &END
&PARMS     ACORF = 0., MXSCAN = 3999, SORF = 1.8, CRITF = 400000, &END
&HEAD      NDFIR = 0, NDLAS = 10000000, NDINC = 720, &END
&IBOX      ISIS = 2, 335, 603,  IEIS = 721, 359, 605, JSIS = 2, 132, 108,
           JEIS =  62, 174, 110, &END
```

3. RUNS OF THE FINE RESOLUTION MODEL

The following provides a summary of the main runs of the fine resolution model. Full details are given in Appendix I.

3.1 Tracers

The 'robust diagnostic' method was used to relax the model towards the observational annual mean temperature and salinity values of the Levitus (1982) dataset. Initially a timescale of 540 days was used for level 6 and below and 180 days in the surface layers (levels 1 - 5). This was to force the surface levels to realistic values as quickly as possible in order to spin-up the model. A longer timescale was used at depth, where errors in the Levitus data had been thought to produce instabilities in the coarse resolution test runs. When the first part of the spin-up was completed (at day 890) the timescale was reduced to 360 days in the upper layers so that the eddy field could develop more naturally. The timescale at depth was also set to 360 days.

The Levitus annual mean temperature and salinity data were read in during the first timestep of the model run and the salinity converted to model units for each latitude row J = 2, JMTM1 using the following code:

```
DO 40 K = 1,KM
READ (65) (TN(I,K,1), I=2,IMTM1)
READ (66) (TN(I,K,2), I=2,IMTM1)
DO 20 M = 1, NT
TN(1, K, M) = TN(IMTM1, K, M)
TN(IMT,K,M) = TN(2,K,M)
```

```
      IF (M .EQ. 2) THEN
      DO 10 I = 1, IMT
      IF (TN(I,K,M) .GE. 99.) TN(I,K,M) = 45.0
      TN(I,K,M) = (TN(I,K,M)/1000.0) - 0.035
10    CONTINUE
      ENDIF
20    CONTINUE
      DO 30 I = 2, IMTM1
      TR1(I-1,K) = TN(I,K,1)
      TR2(I-1,K) = TN(I,K,2)
30    CONTINUE
40    CONTINUE
      BUFFER OUT (8,0) (TR(I,1), TR(IMTM2,KM))
      BUFFER OUT (9,0) (TR(I,2), TR(IMTM2,KM))
```

where TN(I,K,1) is temperature, TN(I,K,2) is salinity, I is the longitude index and K the depth index. The last row of tracers TN(I,K,M) is stored in the KONTRL file for the open boundary calculation. The arrays TR1, TR2 are stored as buffered arrays for efficient input in subroutine STEP. These arrays are used for the relaxation to Levitus in subroutine TRACER.

As in the coarse resolution model, land values of temperature are set to -20°C and land values of salinity set to 0.01 model units (45ppt) to stop convection.

After 6 model years had been completed, new files containing the Levitus annual mean *surface* temperature and salinity were created. These are read in for latitude rows J = 2, JMTM1 and used for relaxation in the top level only.

Towards the end of year 8 of the model run, it was discovered that although the model uses potential temperature, the Levitus data file used for relaxation was *in situ* temperature. The model temperatures at year 5 (day 1826) were converted to potential temperatures and a file created to correspond to Levitus annual mean potential temperature. The period 5 -6 years was re-run with the corrected data. In addition the temperatures in the restart data file at day 3256 were converted to potential temperature and the model run continued from here.

3.2 Winds

The Hellerman & Rosenstein (1983) wind stress dataset was used for the surface forcing. Annual and monthly mean wind stress data are available on a 2° x 2° global grid. Annual mean data were extracted for the latitude range 79°S - 25°S (to correspond to the model gridpoints I = 6, 10,.. 722; J = 9, 17,... 217) and stored in files WINDXF, WINDYF on the CRAY.

The wind forcing was started at the beginning of the third year, with a linear increase from zero to the annual mean value over a period of six months. The wind data are read in and values corresponding to latitude 23° S extrapolated as follows:

```
      DO 10 J = 1, 28
      READ (63) (X(I,J), I=1,180)
      READ (64) (Y(I,J), I=1,180)
10    CONTINUE
      DO 20 I = 1, 180
      X(I,29) = 2 * X(I,28) - X(I,27)
      Y(I,29) = 2 * Y(I,28) - Y(I,27)
20    CONTINUE
```

Interpolation to the model grid is made during the model run for each latitude row, J, using the following code:

```
      JA = (J + 7)/8
      JB = JA + 1
      WB = 0.125 * MOD(J-1,8)
      WA = 1. - WB
      I = 6
      DO 30 II = 1, 180
      WSX(I) = WA * X(II,JA) + WB * X(II,JB)
      WSY(I) = WA * Y(II,JA) + WB * Y(II,JB)
      I = I + 4
30    CONTINUE
      WSX(2) = WSX(IMT)
      WSY(2) = WSY(IMT)
      DO 40 I = 2, IMTM1, 4
      DX = WSX(I+4) - WSX(I)
      WSX(I+1) = WSX(I) + 0.25*DX
      WSX(I+2) = WSX(I) + 0.5 *DX
      WSX(I+3) = WSX(I) + 0.75*DX
      DY = WSY(I+4) - WSY(I)
      WSY(I+1) = WSY(I) + 0.25*DY
      WSY(I+2) = WSY(I) + 0.5 *DY
      WSY(I+3) = WSY(I) + 0.75*DY
40    CONTINUE
```

```
      WSX(1) = WSX(IMTM1)
      WSY(1) = WSY(IMTM1)
```

At the end of six years seasonal winds were introduced. Monthly mean data were extracted for the latitude range 79° S - 23° S and stored in one file HELLERMANWINDF on the CRAY, which is read as follows:

```
      DO 10 J = 1, 29
      READ (65) (X(I,J), I=1,180)
10    CONTINUE
      DO 20 J = 1, 29
      READ (65) (Y(I,J), I=1,180)
20    CONTINUE
```

Interpolation to the model grid is made during the model run for each latitude row, J, using the same code as for the annual mean wind stress. The values at each timestep are obtained by linear interpolation between the consecutive months.

3.3 Bottom friction

Up to 8 years 334 days (day 3256), harmonic (∇^2) horizontal viscosity was used with a viscosity coefficient of 2 x 10^6 cgs units. It was then reduced to 1 x 10^6, the sub-gridscale viscosity expected of 20-30 km eddies. (Diffusivities in the ocean are discussed by Saunders, 1983; 1 x 10^6 is slightly smaller than some of the values he quotes which include the effect of larger scale motions as well.) Non-linear instability was prevented by adding biharmonic friction with coefficient equal to -5 x 10^{18}, so that the damping of the two grid length waves was essentially unchanged.

At the same time, the bottom friction was changed from linear to quadratic of form:

$$\mathbf{F} = -\,CD * \mathbf{U}\,(\mathbf{U}*\mathbf{U} + 25)^{1/2} \quad \text{(coefficient } CD = 0.0014 \text{ in cgs units).}$$

The extra 5cm s^{-1} represents the background noise due to tides, internal waves and other short timescale changes in the ocean current field.

3.4 Model output

The only output files initially produced during the runs of the fine resolution model were the stream function 'cutout' file, produced by subroutine 'ASCOUT' at intervals of

10 model days, and the energetics file, produced by subroutine MATRIX. Restart data, consisting of the data needed to run the model forward, were saved at monthly intervals during the spin-up period and at 10 day intervals during the later part of the run. They are stored on 3480 cartridge tapes on the CRAY. They are also copied to exabyte tape in the international IEEE standard format for transfer to IOSDL for analysis and display. A full list of the data stored on cartridge tape, which may be accessed on the CRAY by members of the FRAM group, is given in Appendix II.

Software was developed to produce horizontal and vertical slices of model fields directly from the restart data files, and is supplied on request with the data. Information on the use of this software, together with the datasets available on exabyte tape, is listed in a further document in this series (Hateley and de Cuevas, 1992). At present, the data may be obtained from the core team at IOSDL. In future, it is likely that it will be archived at the British Oceanographic Data Centre, Bidston.

File names

The naming convention for all output files, is XXXYYYZZZ where:

XXX = three letter run identifier for restart data:
- First = F for the fine resolution model
- Second = A-Z for particular run(if re-runs necessary)
- Third = A-Z for the version of the model (to identify changes)

= one letter run identifier for 'cutout' files:
F for the fine resolution model

YYY = data identifier:
DATASET - model restart data
ENE - energetics file
A - salinity at constant latitude (longitude vs depth slices)
B - salinity at constant longitude (latitude vs depth slices)
C - salinity at constant depth (longitude vs latitude slices)
D - temperature at constant latitude
E - temperature at constant longitude
F - temperature at constant depth
G - u-velocity at constant latitude
H - u-velocity at constant longitude
I - u-velocity at constant depth
J - v-velocity at constant latitude
K - v-velocity at constant longitude
L - v-velocity at constant depth
M - w-velocity at constant latitude
N - w-velocity at constant longitude

O - w-velocity at constant depth
P - stream function

ZZZ = run number for job log and energetics file
day of output for 'cutout' files.

The filetype is either 'CARDS' for data 'cutouts', or 'LISTING' for the job log and energetics files.

Header details

The header for 'cutout' files is the same as that used for the coarse resolution model, with modified variables, FROM, TO, INCR and NOPS. The format code in record 1 is CD to distinguish from CC used for the coarse resolution model. An extra record was inserted:

Record 11 — Pairs of items of the form 'keyword' followed by a numeric value to provide extra information. The keywords permitted are TTSEC, LEVEL, DEPTH, ITT, LAT, LONG, MONTH. The line may be left blank if not required (but must be included).

Energetics output file

The energetics file, which is produced every 10 days, contains:

Each timestep
total kinetic energy normalized by volume (KE)
volume average of absolute change of temperature (DTEMP)
volume average of absolute change of salinity (DSALT)
relaxation scan counter

Every 2 days
current meter diagnostics:

u, v at points	I = 602,	J = 77,	K = 17, 18
		J = 78,	K = 17, 18
	I = 603,	J = 77,	K = 17, 18
		J = 78,	K = 17, 18

where I = 602 corresponds to longitude 300° E
J = 77 corresponds to latitude 60° S.

This code was removed when other current meters were installed and written to a separate file.

Every 10 days
Maximum positive and negative differences from Levitus tracer values for each level (with corresponding I and J values), with the mean difference and variance for that level.
Maximum u, v and w velocities for each level (with corresponding I and J values).
A summary of the work done and the change in tracers.
The northward transport of heat and salt at all I values.
The meridional mass transport at all levels at all J values.
The value of the stream function at Antarctica.

Running plots are kept of KE, DTEMP, DSALT and the stream function at Antarctica. The time series of the current meter data has also been extracted from the energetics file.

Eddy statistics

Eddy statistics data were collected during the last 6 years of the model run. The code used to collect the data is based on that developed by Dr Roger Brugge at Imperial College. In its original form the code collected 28 statistical values at each model node. This would have meant an eight-fold increase in storage requirements and caused a significant downgrading of the model's performance. As implemented, the same statistical values (and an additional eight after day 4048) are collected on a sub-grid of the model: - from every fourth longitude node (starting at I = 2), every fourth latitiude node (starting at J = 5), and at seven vertical levels (K = 4, 9, 12, 14, 19, 23, 28).

The statistics are updated once every model day (at midday). All values are re-set at the beginning of each month and stored at the end of the model month. Both 'raw' data and values derived from the month's raw data (such as the mean temperature at each node) are stored. Averages over longer periods may then be constructed using the raw data from sequences of monthly files. Details of the fields stored in each file are given in a 200 line header which precedes the data.

3.5 Run details

Table 3 below gives the conversion from years to model days. In Appendix I a full list is given of the major and minor changes made to the model code during the model run, including parameter changes in the input file, fortran unit 5. This is followed by a table of all the model runs, with the days covered by each one. Appendix II contains a summary of the files used to run the model. Finally details of the files needed for processing the output and the storage of the model data are given in Appendix III.

Table 3

Year	*Day*
0	0
1	365
2	730
3	1095
4	1461
5	1826
6	2191
7	2556
8	2922
9	3287
10	3652
11	4017
12	4383
13	4748
14	5113
15	5478
16	5844

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APPENDIX I

THE MAIN FINE RESOLUTION MODEL RUNS

1. Model parameter and code changes

Major changes were recorded by a change in the name of the deck used to update the basic Cox code. The first deck used was FAA DECK, which has been described above. The detailed changes made during the run are as follows:

Run FBA41	&CONTRL	NFIRST = 0, NLAST = 72, NNERGY = 72, NMIX = 24, NWRITE = 999, NDW=5, NTSI=1, NA=0, NB=0, NC=0, &END
	&PARMS	ACORF = 0., MXSCAN = 1999, SORF = 1.85, CRITF = 39000, &END
Run FAA43	&PARMS	ACORF = 0., MXSCAN = 3999, SORF = 1.963, CRITF = 36680, &END
Run FAA46	&PARMS	ACORF = 0., MXSCAN = 3999, SORF = 1.963, CRITF = 43620, &END
Run FAA49	&PARMS	ACORF = 0., MXSCAN = 3999, SORF = 1.9, CRITF = 36680, &END
Run FAA60	The relaxation code was modified to mask residuals over land.	
Run FAC1	&EDDY	AMF = 2.E6, AHF = 1.E6, FKPMF = 1., FKPHF = 0.5, &END
	&TSTEPS	DTTSF = 2400, DTUVF = 2400, DTSFF = 2400, &END
	&PARMS	ACORF = 0., MXSCAN = 6999, SORF = 1.9, CRITF = 36680, &END

Several routines were added for manipulating dates so that datasets can be saved at the end of each calendar month. The model is assumed to start at 1989/01/01:00:00:00.

Dynamic assignment of input datasets was implemented - a log of the restart datasets is kept, which is read at the start of a model run to determine the latest dataset. Every time a dataset is saved, the log is updated. The energetics and stream function files are disposed to the IBM front-end every 10 model days, and new files assigned. The filenames of the energetics and stream function output files are of form 'ENExxx' and 'FPxxx'where xxx is the day number on which the output starts.

The model run terminates automatically if the number of timesteps has been exceeded or if fewer than 200 cpu seconds remains for the job.

Run FAC5	&PARMS	ACORF = 0., MXSCAN = 8999, SORF = 1.9, CRITF = 36680, &END

Run FAC12	&TSTEPS DTTSF = 1800, DTUVF = 1800, DTSFF = 1800, &END
Run FAD1	&TSTEPS DTTSF = 1200, DTUVF = 1200, DTSFF = 1200, &END Correction to open boundary code.
Run FAD4	&TSTEPS DTTSF = 2400, DTUVF = 2400, DTSFF = 2400, &END &PARMS ACORF = 0., MXSCAN = 8999, SORF = 1.9, CRITF = 436200, &END
Run FAD6	&TSTEPS DTTSF = 2400, DTUVF = 2400, DTSFF = 2400, &END
Run FAD15	Timescale for relaxation to Levitus temperature and salinity changed to 360 days at all levels. Correction made to buffer checks for northern boundary.
Run FAD19	Parameters AH, AM linearly increased to 2 x 10**7 over the northernmost 10 rows to avoid problems at the boundary. Stream function P(I,J) set to a masked land value only if the depths at u,v points (I,J), (I-1,J), (I,J-1) *and* (I-1,J-1) are all zero. The stream function is now plotted for the range of J = 2, JMT (not J = 2, JMTM1 as previously).
Run FAE27	Updates sorted, conflicts and Cyber-specific code removed. Code added to send stream function to VMSFE for David Stevens once per day (from day 1750).
Run FAF35	Disk-striping implemented to speed-up execution, in conjunction with microtasking subroutines in CLINIC, TRACER and RELAX. Subroutine FILES added for dynamic assignment of files. Code added to output temperature depth slab to VMSFE for David Stevens (from day 2131).
Run FAF37	&CONTRL NFIRST = 0, NLAST = 72, NNERGY = 72, NMIX = 36, NWRITE = 999, NDW=5, NTSI=1, NA=0, NB=0, NC=0, &END Integer function JDAY1 modified to reflect model start in 1901 rather than 1989. Correction to Levitus surface salinity which was being scaled twice. Common block for surface forcing made a *named* COMMON block, FORCE.
Run FAF38	Current meters installed to be output every 4 hours for 100 days at the grid points closest to observations as given in the following table:

Table 4

Latitude (d m s)	*Longitude* (d m s)	*Depth* (m)	*I*	*J*	*K*
62 26 30 S	34 45 30 W	535	652	67	10
		3010	652	67	22
61 56 06 S	26 11 54 W		54	69	8, 10, 14
58 59 00 S	25 44 00 E		53	81	8, 12, 13, 28
55 57 30 S	21 57 06 E		46	93	8, 12, 13, 26
63 11 S	42 44 W	3800	637	64	22
63 56 S	40 53 W	4600	640	61	27
60 11 S	38 10 W	3000	646	76	19
59 09 S	37 58 W	2900	646	80	20
60 19 S	43 46 W	5500	635	76	25
62 04 S	40 35 W	3300	641	69	21

After these had been removed, others were installed as follows:

Table 4a

Latitude	*Longitude*	*I*	*J*	*K*
38 . 12 °S	22 . 25 °E	46	164	7, 13, 17, 22
38 . 12 °S	38 . 12 °E	79	164	"
41 . 88 °S	50 . 25 °E	102	149	"
47 . 38 °S	18 . 00 °E	38	127	"
50 . 38 °S	109 . 25 °E	220	115	"
51 . 38 °S	147 . 25 °E	296	111	"
56 . 88 °S	69 . 25 °W	583	89	"
59 . 62 °S	160 . 75 °E	323	78	"
59 . 62 °S	172 . 75 °W	376	78	"
59 . 62 °S	139 . 25 °W	443	78	"
60 . 88 °S	88 . 25 °W	545	73	"

Run FAF63 A new restart dataset, FAADATASET3120, was created with corrected potential temperature in the slabs and TN array.

Run FAG64 *(A re-run of years 5 - 6 with potential temperature)*

Annual mean winds maintained until end of year (day 2191) and dataset created with pressure, USTAR and VSTAR fields.

Run FAH71 &EDDY AMF = 0., AHF = 0., BMF = -1.E+19, BHF = -1.E+19, FKPMF = 1., FKPHF = 0.5, &END

Quadratic bottom stress with coefficient CD = 0.0014.

Run FAI *(Re-run from day 3256)*

&EDDY AMF = 1.E6., AHF = 1.E6., BMF = -1.E+19, BHF = -1.E+19, FKPMF = 1., FKPHF = 0.5, &END

UNICOS operating system - dynamic assignment of files and run numbers not working.

Code included to send salinity output slabs to Tim Grose on RL.VMSFE (day 3256 - 4123, 5218 - 5608).

Eddy statistics code implemented.

Run FAI *(from day 3292):*

&EDDY AMF = 1.E6., AHF = 1.E6., BMF = -5.E+18, BHF = -5.E+18, FKPMF = 1., FKPHF = 0.5, &END

Run FAI76 Eddy statistics file enlarged to include salinity arrays.

Run FAK112 Restart data and eddy statistics stored every day for 1 month (day 5082 - 5113).

Run FAL132 Increased friction near northern boundary only in Indian Ocean.

2. Run numbers and timesteps

Run FAA

Run number	*Days*	*Timesteps*
FAA41	0 - 1	0 - 72
FBA41	1 - 10	73 - 720
FAA42	10 - 20	721 - 1440
FAA43	20 - 30	1441 - 2160
FAA44	30 - 40	2161 - 2880
FAA45	40 - 70	2881 - 5040
FAA46	70 - 100	5041 - 7200
FAA47	100 - 130	7201 - 9360
FAA48	130 - 140	9361 - 10080
FAA49	140 - 150	10080 - 10800
FAA50	150 - 160	10801 - 11520
FAA51	160 - 170	11521 - 12240
FAA52	170 - 180	12241 - 12960
FAA53	180 - 190	12961 - 13680
FAA54	190 - 200	13681 - 14400
FAA55	200 - 210	14401 - 15120
FAA56	210 - 220	15121 - 15840
FAA57	220 - 230	15841 - 16560
FAA58	230 - 240	16561 - 17280
FAA59	240 - 250	17281 - 18000
FAA60	250 - 260	18001 - 18720
FAA61	260 - 270	18721 - 19440

Run FAC

Run number	*Days*	*Timesteps*
FAC1	270 - 273	19441 - 19800
FAC4	310 - 369	20881 - 23026
FAC5	369 - 396	23027 - 23976
FAC6	396 - 457	23977 - 26199
FAC7	457 - 517	26200 - 28343
FAC8	517 - 533	28344 - 28920
FAC9	530 - 578	28801 - 30531
FAC10	578 - 619	30532 - 32027
FAC11	619 - 634	32028 - 32545

Run FAD

Run number	*Days*	*Timesteps*
FAD1	516 - 544	28297 - 30312
FAD3	565 - 580	31861 - 32903
FAD4	577 - 594	32689 - 33329
FAD5	594 - 650	33330 - 35468
FAD12	630 - 660	32401 - 33858
FAD13	638 - 646	32785 - 33181
FAD6	650 - 669	35317 - 36033
FAD7	669 - 670	36001 - 36036
FAD8	670 - 726	36037 - 38075
FAD9	726 - 730	38076 - 38204
FAD10	730	38197 - 38204
FAD11	730 - 796	38197 - 40607
FBD12	796 - 863	40608 - 43013
FBD13	863 - 870	40609 -
FAD15	890 - 978	43957 - 47124
FAD16	978 - 1061	47125 - 50139
FAD17	1061 - 1145	50141 - 53155
FAD18	1145 - 1200	53156 - 55423
FAD19	1186 - 1269	54612 - 57613
FAD20	1269 - 1353	57614 - 60657
FAD21	1353 - 1437	60658 - 63671
FAD22	1437 - 1519	63672 - 66614
FAD24	1530 - 1612	66997 - 69976
FAD25	1612 - 1697	60077 - 73010
FAD26	1697 - 1759	73011 - 75266

Run FAE

Run number	*Days*	*Timesteps*
FAE27	1750 - 1760	74905 - 75288
FAE28	1760 - 1787	75289 - 76272
FAE29	1780 - 1866	76009 - 79080
FAE30	1866 - 1953	79081 - 82224
FAE31	1953 - 2016	82225 - 84480
FAE32	2010 - 2045	84265 - 85560
FAE33	2040 - 2045	85345 - 85536
FAE34	2045 - 2131	85537 - 88632

Run FAF

Run number	*Days*	*Timesteps*
FAF35	2131 - 2182	88633 - 90480
FAF36	2182 - 2200	90481 - 91128
FBF36	2160 - 2173	89665 - 90120
FAF37	2170 - 2215	90025 - 91656
FBF37	2191 - 2200	90795 - 91104
FAF39	2230 - 2287	92185 - 94248
FBF38	2191 - 2199	90795 - 91080
FBF39	2199 - 2267	91081 - 93528
FAF40	2267 - 2280	93529 - 94008
FAF41	2280 - 2294	94009 - 94488
FAF42	2294 - 2306	94489 - 94920
FAF43	2306 - 2318	94921 - 95352
FAF45	2362 - 2411	96961 - 98712
FAF46	2411 - 2457	98713 - 100392
FAF47	2457 - 2500	100393 - 101904
FAF48	2500 - 2549	101905 - 103680
FAF49	2549 - 2594	103681 - 105336
FAF50	2594 - 2644	105337 - 107088
FAF51	2644 - 2692	107089 - 108840
FAF52	2692 - 2749	108841 - 110904
FAF53	2749 - 2804	110905 - 112872
FAF54	2804 - 2854	112873 - 114672
FAF55	2854 - 2905	114673 - 116520
FAF56	2905 - 2954	116521 - 118272
FAF57	2954 - 2974	118273 - 118968
FAF58	2970 - 2973	118836 - 118968
FAF59	2973 - 2987	118969 - 119448
FAF60	2987 - 3063	119449 - 122208
FAF61	3063 - 3141	122209 - 124992
FAF62	3141 - 3217	124993 - 127752
FAF63	3210 - 3256	127465 - 129132

Run FAG (re-run 5 - 6 years)

Run number	*Days*	*Timesteps*
FAG64	1826 - 1900	77625 - 80304
FAG65	1900 - 1950	80305 - 82104
FAG66	1946 - 2000	81961 - 83928
FAG67		
FBG67	2000 - 2007	83928 - 84264
FAG68	2007 - 2017	84192 - 84624
FAG69	2010 - 2087	84264 - 87072
FAG70	2087 - 2166	87073 - 89904
FAG71	2166 - 2191	89905 - 90792

Run FAH

Run number	*Days*	*Timesteps*
FAH71	3256 - 3313	129133 - 131184
FAH72	3313 - 3363	131185 - 132984
FAH74	3380 - 3417	133597 - 134976
FBH74	3287 - 3300	130249 - 130704
FAH75	3290 - 3345	130705 - 132336
FAH76	3345 - 3346	132336 - 132372
FAH77	3346 - 3360	132373 - 132864
FAH78	3350 - 3377	132865 - 133488
FAH79	3370 - 3421	133248 - 135072
FAH80	3421 - 3440	135096 - 135672
FAH81	3430 - 3484	135408 - 137352
FAH82	3484 - 3515	137353 - 138480
FAH83	3510 - 3561	138288 - 140112
FAH84	3561 - 3608	140113 - 141816
FAH85	3600 - 3620	141528 - 142224
FAH86	3610 - 3633	141888 - 142728
FAH87	3630 - 3652	142608 - 143376
FAH88	3650 - 3652	143328 - 143376

Run FAI (UNICOS - initially no job log numbers)

Run number	*Days*	*Timesteps*
FAI	3256 - 3264	129133 - 129420
FAI	3264 - 3290	129421 - 130356
FAI	3290 - 3296	130357 - 130572
FAI	3296 - 3300	130573 - 130716
FAI	3300 - 3308	130717 - 131004
FAI	3308 - 3322	131005 - 131508
FAI	3322 - 3338	131509 - 132084
FAI	3338 - 3364	132085 - 133020
FAI	3364 - 3374	133021 - 133380
FAI	3374 - 3380	133381 - 133596
FAI	3380 - 3396	133597 - 134172
FAI	3396 - 3407	134173 - 134568
FAI29	3407 - 3419	134569 - 135025
FAI30	3419 - 3420	135025 - 135036
FAI31	3420 - 3424	135037 - 135180
FAI32	2424 - 3429	135181 - 135393
FAI33	3429 - 3432	135394 - 135468
FAI34	3432 - 3434	135469 - 135540
FAI35	3434 - 3436	135541 - 135612
FAI36	3436 - 3439	135613 - 135746
FAI37	3439 - 3452	135747 - 136188
FAI38	3452 - 3462	136189 - 136548
FAI39	3462 - 3472	136549 - 136908
FAI40	3468 - 3484	136765 - 137340
FAI41	3484 - 3498	137341 - 137844
FAI42	3498 - 3510	137845 - 138276
FBI42	3510 - 3520	138277 - 138636
FAI43	3520 - 3535	138637 - 139192
FAI44	3535 - 3548	139192 - 139644
FAI45	3548 - 3562	139645 - 140148
FAI46	3562 - 3574	140148 - 140580
FAI47	3574 - 3588	140581 - 141084
FAI48	3588 - 3605	141085 - 141705
FAI49	3605 - 3618	141706 - 142164
FAI50	3618 - 3620	142165 - 142236
FAI51	3620 - 3621	142237 - 142272
FAI52	3621 - 3622	142273 - 142308
FAI53	3622 - 3624	142309 - 142380
FAI54	3624 - 3626	142381 - 142452
FAI55	3626 - 3628	142453 - 142524
FAI56	3628 - 3630	142525 - 142596
FAI57	3630 - 3632	142597 - 142668
FAI58	3632 - 3634	142669 - 142740
FAI59	3636 - 3680	142741 - 144396

Run FAI (continued)

Run Number	*Days*	*Timesteps*
FAI60	3682 - 3714	144397 - 145620
FAI61	3708 - 3752	145405 - 146988
FAI62	3734 - 3736	146341 - 146412
FAI63	3736 - 3742	146413 - 146628
FAI64	3752 - 3780	146989 - 147996
FAI65	3780 - 3802	147997 - 148788
FAI66	3798 - 3826	148645 - 149652
FAI67	3826 - 3914	149653 - 152820
FBI67	3914 - 3922	152821 - 153108
FAI68	3922 - 3944	153109 - 153900
FAI69	3944 - 3950	153901 - 154116
FAI70	3950 - 3968	154117 - 154764
FAI71	3968 - 3980	154765 - 155196
FAI72	3980 - 4008	155197 - 156204
FAI73	3990 - 4012	155557 - 156348
FBI73	4012 - 4017	156349 - 156528
FAI74	4017 - 4050	156529 - 157715
FAI75	4045 - 4048	157537 - 157644
FAI76	4048 - 4081	157645 - 158832
FAI77	4080 - 4124	158797 - 160380
FAI78	4110 - 4115	159877 - 160056
FAI79	4115 - 4155	160057 - 161496
FAI80	4140 - 4185	160957 - 162576
FAI81	4170 - 4210	162037 - 163476
FB181	4200 - 4225	163117 - 164016
FAI82	4225	
FAI83	4225 - 4235	164017 - 164276
FAI84	4235 - 4240	164277 - 164556
FAI85	4240 - 4255	164557 - 165096
FAI86	4255 - 4260	165097 - 165276
FAI87	4260 - 4281	165277 - 166032
FAI88	4265 - 4307	165457 - 166968
FAI89	4295 - 4340	166537 - 168156
FAI90	4325 - 4371	167617 - 169299
FAI91	4371 - 4400	169300 - 170316
FAI92	4385 - 4458	169777 - 172404
FAI93	4445 - 4480	171937 - 173196
FBI93	4475 - 4500	173017 - 173916
FCI93	4495 - 4515	173736 - 174456
FDI93	4515 - 4520	174457 - 174636

Run FAI (continued)

Run Number	*Days*	*Timestep*
FAI94	4520 - 4560	174637 - 176076
FBI94	4560 - 4605	176077 - 177696
FAI95	4605 - 4632	176697 - 178675
FAI96	4632 - 4674	178676 - 180207
FAI97	4674 - 4710	180208 - 181476
FAI98	4710 - 4734	181477 - 182344
FAI99	4734 - 4760	182345 - 183276
FAI100	4760 - 4787	183277 - 184272
FAI101	4787 - 4815	184273 - 185256
FAI102	4815 - 4842	185257 - 186231
FAI103	4842 - 4870	186232 - 187236
FAI104	4870 - 4889	187237 - 187933
FAI105	4889 - 4899	187934 - 188280
FAI106	4899 - 4952	188281 - 190219
FAI107	4952 - 4960	190220 - 190476
FAI108	4960 - 4999	190477 - 191901
FAI109	4999 - 5030	191902 - 193007
FAI110	5030 - 5069	193008 - 194401
FAI111	5069 - 5082	194402 - 194868

Run FAK

Run number	*Days*	*Timestep*
FAK112	5082 - 5087	194869 - 195048
FAK113	5087 - 5092	195049 - 195228
FAK114	5092 - 5097	195229 - 195408
FAK115	5097 - 5105	195409 - 195696
FAK116	5103 - 5109	195625 - 195840
FAK117	5109 - 5113	195841 - 195984
FAK118	5113 - 5156	195985 - 197532
FAK119	5156 - 5194	197533 - 198900
FAK120	5113 - 5172	195841 - 198108
FAK121	5172 - 5217	198109 - 199731
FAK122	5217 - 5256	199732 - 201133
FAK123	5256 - 5293	201134 - 202464
FAK124	5293	
FAK125	5290 - 5330	202357 - 203797
FBK125	5330 - 5350	203797 - 204516
FAK126	5350 - 5388	204517 - 205900
FAK127	5388 - 5430	205900 - 207396
FAK128	5430 - 5472	207397 - 208926
FAK129	5472 - 5478	208927 - 209124
FAK130	5478 - 5519	209125 - 210610
FAK131	5519 - 5578	210611 - 212746
FBK131	5578 - 5600	212747 - 213516

Run FAL

Run number	*Days*	*Timesteps*
FAL132	5520 - 5558	210637 - 211716
FAL133	5558 - 5580	211717 - 212796
FAL134	5580 - 5622	212797 - 214321
FAL135		
FAL136	5622 - 5688	214322 - 216396
FAL137	5688 - 5728	216397 - 218124
FAL138	5722 - 5760	217909 - 219276
FAL139	5760 - 5770	219277 - 219636
FBL139	5770 - 5806	219636 - 220932
FAL140	5806 - 5822	220933 - 221508
FAL141	5790 - 5830	220357 - 221796
FAL142	5830 - 5842	221797 - 222228
FAL143	5790 - 5829	220357 - 221765
FAL144	5829 - 5844	221766 - 222300

3. Statistics of computer usage

The following tables provide a summary of the CRAY X-MP usage by the main FRAM model runs. As some job logs were lost, not all runs could be included.

Initially the model was run single tasked, using only one processor of the four processor X-MP. Table 5 shows the number of model days achieved by each run, the total CPU time taken, the time spent waiting (ie. swapped out of the machine), the time taken by input/output processes (I/O), the ratio of I/O time to total CPU time and the rate (in megaflops) at which the job was running. Initially the ratio of I/O to CPU time was rather constant at 0.08 but as usage of the machine increased, both this ratio and the wait time increased substantially, demonstrating the poor through-put being achieved.

Disk-striping was implemented to improve the I/O rate and the model code was microtasked. The model was run initially using two processors and Table 6 shows the results from these runs. Although the ratio of I/O time to CPU time improved after the first few runs, the wait time was still causing poor through-put.

Table 5

Run	*Number of Model Days*	*CPU Time (h : m)*	*Wait Time (h : m)*	*I/O Time (h : m)*	*(I/O) / CPU Time*	*Rate (mfl)*
FAC4	59	23 : 50	49 : 01	1 : 51	0.08	79
FAC5	27	09 : 44	29 : 17	0 : 44	0.08	78
FAC6	61	23 : 50	64 : 49	1 : 54	0.08	79
FAC7	60	23 : 50	76 : 37	1 : 49	0.08	78
FAC8	13	06 : 38	19 : 07	0 : 29	0.07	83
FAC9	48	23 : 50	80 : 06	1 : 37	0.07	86
FAC10	41	23 : 50	44 : 11	1 : 35	0.07	85
FAC11	15	07 : 02	51 : 18	0 : 25	0.06	83
FAD5	56	22 ; 22	49 : 11	2 : 23	0.11	97
FAD6	19	08 : 08	18 : 46	1 : 23	0.08	96
FAD8	56	23 : 50	79 : 25	2 : 05	0.09	96
FAD11	46	23 : 50	80 : 18	3 : 12	0.13	91
FAD12	67	23 : 50	19 : 28	2 : 55	0.12	93
FAD15	88	23 : 51	53 : 24	3 : 21	0.14	91
FAD16	83	23 : 50	76 : 03	3 : 16	0.14	90
FAD17	84	23 : 50	83 : 17	1 : 45	0.07	90
FAD18	55	18 : 20	5 : 44	6 : 59	0.38	94
FAD19	83	23 : 50	37 : 26	4 : 05	0.17	89
FAD20	93	23 : 50	17 : 33	2 : 43	0.11	91
FAD21	84	23 : 50	53 : 55	6 : 20	0.27	90
FAD22	72	23 : 50	32 : 58	4 : 42	0.20	90
FAD24	82	23 : 50	119 : 04	2 : 52	0.12	89
FAD25	85	23 : 50	112 : 12	4 : 01	0.17	91
FAD26	62	17 : 53	72 : 50	2 : 39	0.15	90
FAD27	10	2 : 49	19 : 01	0 : 27	0.16	90
FAD28	20	7 : 38	38 : 10	4 : 43	0.62	89
FAD29	86	23 : 50	122 : 02	5 : 03	0.21	89
FAE30	87	23 : 50	120 : 12	4 : 51	0.20	89
FAE31	57	17 : 36	15 : 00	11 : 17	0.64	88
FAE32	35	10 : 40	95 : 07	2 : 14	0.21	89
FAE34	86	23 : 50	66 : 29	3 : 59	0.17	88

Table 6

Run	*Number of Model Days*	*CPU time (h : m)*	*Wait Time (h : m)*	*I/O Time (h : m)*	*(I/O) / CPU Time*	*Rate (mfl)*
FAF35	51	23 : 50	159 : 50	10 : 26	0.44	67
FAF36	21	4 : 55	174 : 45	2 : 48	0.56	66
FAF37	45	23 : 50	136 : 25	7 : 36	0.32	74
FBF37	9	5 : 51	79 : 09	0 : 31	0.09	85
FAF39	58	19 : 59	171 : 06	2 : 35	0.13	72
FBF38	8	5 : 31	61 : 09	0 : 25	0.08	85
FBF39	68	23 : 50	184 : 50	3 : 28	0.15	72

The remaining runs under the COS operating system were made with three processors and the results are given in Table 7. Looking at individual runs, it can be seen that the best rates were achieved when most of the processing was being done by a single processor. No significant improvement in wall clock time was achieved in running multi-tasked. Table 8 gives details of the breakdown in single processor time and multi-processor time for the runs made using three processors.

With the installation of the UNICOS operating system, the disk-striping and micro-tasking code was removed. CRAY autotasking was used instead to improve efficiency, by optimising the use of idle CPUs. Table 9 summarises the FRAM usage under UNICOS. The table differs from the previous ones because different accounting statistics are given in the job log under UNICOS. The table is incomplete because frequent failures in the early days resulted in the loss of accounting statistics. Only runs of longer than three model days, which completed normally, are included in the table. Note that when the average number of CPUs used is greater than 3, the user CPU time is sometimes actually less than the elapsed time.

Table 7

Run	Number of Model Days	CPU Time (h : m)	Wait Time (h : m)	I/O Time (h : m)	(I/O) / CPU Time	Rate (mfl)
FAF40	13	5 : 17	73 : 30	0 : 48	0.15	65
FAF41	14	5 : 17	57 : 34	0 : 43	0.14	66
FAF42	12	5 : 17	55 : 22	0 : 50	0.16	57
FAF43	12	5 : 18	68 : 48	: 46	0.14	56
FAF45	49	23 : 38	22 : 36	2 : 45	0.12	51
FAF46	46	23 : 38	34 : 21	1 : 53	0.08	49
FAF47	43	23 : 38	7 : 55	2 : 05	0.09	44
FAF48	49	23 : 39	19 : 13	2 : 17	0.10	51
FAF49	45	23 : 38	42 : 40	2 : 06	0.09	48
FAF50	50	23 : 38	15 : 25	1 : 06	0.05	51
FAF51	48	23 : 38	55 : 00	2 : 01	0.08	51
FAF52	57	23 : 38	38 : 19	1 : 57	0.08	61
FAF53	55	23 : 38	93 : 05	2 : 06	0.09	58
FAF54	50	23 : 38	166 : 17	3 : 09	0.13	52
FAF55	51	23 : 38	141 : 29	2 : 54	0.12	53
FAF56	49	23 : 38	0 : 43	2 : 18	0.10	51
FAF57	20	10 : 32	102 : 28	: 44	0.07	61
FAF58	3	1 : 19	41 : 46	: 09	0.11	69
FAF59	14	5 : 17	130 : 50	1 : 00	0.19	62
FAF60	76	23 : 37	379 : 51	6 : 40	0.28	81
FAF61	78	23 : 37	80 : 14	2 : 32	0.11	81
FAF62	69	23 : 23	354 : 56	4 : 31	0.19	82
FAF63	46	23 : 01	117 : 07	5 : 41	0.25	92
FAF64	74	22 : 12	153 : 02	6 : 49	0.31	87
FAF65	50	15 : 08	146 : 59	13 : 11	0.87	83
FAF66	54	19 : 18	134 : 20	10 : 06	0.52	76
FAF69	77	23 : 37	195 : 57	8 : 13	0.35	83
FAF70	79	23 : 37	173 : 13	6 : 08	0.26	84
FAF71	25	6 : 41	84 : 23	4 : 26	0.66	92
FBF71	68	23 : 37	5 : 57	3 : 57	0.17	100
FAF72	46	23 : 38	54 : 13	1 : 39	0.07	76
FAF73	27	15 : 53	48 : 27	1 : 03	0.07	73
FAG71	57	23 : 37	105 : 08	6 : 51	0.29	79
FAG72	50	23 : 37	68 : 15	1 : 51	0.08	82
FAH74	37	19 : 23	71 : 39	1 : 25	0.07	86
FAH75	55	23 : 37	147 : 19	2 : 05	0.09	87
FAH76	1	1 : 51	17 : 02	: 16	0.14	92
FAH77	14	5 : 46	56 : 54	1 : 08	0.20	96
FAH78	27	11 : 51	83 : 57	: 55	0.08	88
FAH79	51	23 : 37	99 : 03	1 : 30	0.06	87
FAH80	19	9 : 50	19 : 32	: 27	0.05	66
FAH81	54	23 : 37	230 : 30	2 : 19	0.10	93
FAH82	30	13 : 07	134 : 29	1 : 11	0.09	97
FAH83	51	23 : 37	143 : 18	2 : 55	0.12	87

Table 8

Run	*Number of Model Days*	*Total CPU Time (h : m)*	*Single CPU Time (h : m)*	*Multiple CPU Time (h : m)*	*Rate (mfl)*
FAF42	12	5 : 17	2 : 26	0 : 57	57
FAF43	12	5 : 18	2 : 22	0 : 58	56
FAF45	49	23 : 38	9 : 24	4 : 45	51
FAF46	46	23 : 38	8 : 17	5 : 08	49
FAF47	43	23 : 38	6 : 42	5 : 39	44
FAF48	49	23 : 38	9 : 03	4 : 52	51
FAF49	45	23 : 38	7 : 53	5 : 14	48
FAF50	50	23 : 38	8 : 05	5 : 12	51
FAF51	48	23 : 38	8 : 53	4 : 56	51
FAF52	57	23 : 38	12 : 51	3 : 40	60
FAF53	55	23 : 38	11 : 25	4 : 08	58
FAF54	50	23 : 38	9 : 44	4 : 39	52
FAF55	51	23 : 38	10 : 01	4 : 32	53
FAF56	49	23 : 38	8 : 50	4 : 56	51
FAF57	20	10 : 32	4 : 39	1 : 58	61
FAF58	3	1 : 19	0 : 53	0 : 09	69
FAF59	14	5 : 17	2 : 59	0 : 46	62
FAF60	76	23 : 37	17 : 21	2 : 05	81
FAF61	78	23 : 37	17 : 01	2 : 10	81
FAF62	69	23 : 37	17 : 37	1 : 55	82
FAF63	46	13 : 01	11 : 17	1 : 44	92
FAF64	74	22 : 12	17 : 57	1 : 25	87
FAF65	50	15 : 08	11 : 47	1 : 05	83
FAF66	54	19 : 18	13 : 22	1 : 58	76
FAF69	77	23 : 37	18 : 13	1 : 48	83
FAF70	80	23 : 37	18 : 34	1 : 41	84
FAF71	25	6 : 41	6 : 11	: 10	92
FBF71	57	23 : 37	16 : 39	2 : 20	79
FAF72	50	23 : 37	16 : 03	2 : 31	82
FAH74	37	19 : 23	13 : 41	1 : 50	86
FAH75	55	23 : 37	18 : 51	1 : 35	87
FAH76	1	1 : 51	1 : 37	: 05	92
FAH77	14	5 : 46	5 : 15	: 10	96
FAH78	27	11 : 51	9 : 26	: 47	88
FAH79	51	23 : 39	18 : 05	1 : 50	87
FAH80	19	9 : 50	4 : 27	1 : 47	66
FAH81	54	23 : 37	20 : 30	1 : 00	93
FAH82	31	13 : 07	12 : 16	: 17	97
FAH83	51	23 : 37	18 : 20	1 : 45	87

Table 9

Run	*Number of Model Days*	*Total Lapsed Time (H : m)*	*Total CPU Time (Hours)*	*Average Concurrent CPUs*
FAI40	16	22 : 28	14 : 22	2.39
FAI41	14	31 : 10	14 : 35	2.35
FAI43	15	25 : 54	14 : 14	2.41
FAI48	17	27 : 00	14 : 44	2.29
FAI74	33	31 : 34	17 : 32	2.54
FA180	45	15 : 08	19 : 20	3.23
FAI81	44	21 : 51	19 : 20	2.61
FAI88	42	38 : 58	18 : 18	2.57
FAI90	46	15 : 27	19 : 45	3.15
FAI95	27	19 : 25	11 : 33	2.65
FAI96	42	29 : 30	18 : 03	2.52
FAI98	24	19 : 48	10 : 58	2.55
FAI99	26	16 : 35	10 : 58	2.72
FAI100	27	13 : 42	11 : 45	2.88
FAI101	28	10 : 04	11 : 50	3.14
FAI102	27	9 : 15	11 : 21	3.01
FAI103	28	6 : 22	11 : 50	3.16
FAI106	53	56 : 32	18 : 32	2.49
FAI108	39	49 : 05	17 : 50	2.55
FAI110	39	40 : 13	18 : 22	2.77
FAI111	13	8 : 30	5 : 26	2.88
FAK112	5	3 : 50	2 : 20	2.54
FAK113	5	3 : 56	2 : 19	2.35
FAK114	5	4 : 24	2 : 22	2.42
FAK115	8	8 : 12	4 : 15	2.47
FAK116	6	5 : 59	2 : 40	2.41
FAK117	4	3 : 08	1 : 52	2.41
FAK118	43	20 : 24	19 : 25	2.76
FAK119	38	23 : 13	18 : 13	2.62
FAK121	45	15 : 09	20 : 14	3.36
FAK122	39	29 : 25	18 : 49	2.45
FAK123	37	27 : 58	18 : 18	2.43
FAK125	40	24 : 46	19 : 07	2.71
FAK126	38	23 : 26	19 : 13	2.56
FAK127	42	26 : 59	19 : 27	2.55
FAK128	42	22 : 38	19 : 24	2.72
FAK129	6	5 : 37	2 : 54	2.54
FAK130	41	22 : 32	18 : 52	2.94
FAK131	59	31 : 24	18 : 55	2.48
FAL132	38	36 : 47	18 : 35	2.83
FAL134	42	20 : 27	19 : 38	3.10
FAL137	40	29 : 33	19 : 07	3.07
FAL138	38	30 : 26	18 : 38	2.76
FAL139	36	29 : 09	17 : 56	2.69
FAL141	40	31 : 33	18 : 43	2.64
FAL143	39	28 : 28	18 : 40	2.72
FAL144	15	10 : 13	7 : 02	2.73

APPENDIX II

FILES FOR RUNNING THE FINE RESOLUTION MODEL

The fine resolution model was run on the CRAY X-MP at the Atlas Centre of the Rutherford Appleton Laboratory. Communication to the CRAY was via the IBM front-end. As with the coarse resolution model, the restart, topography and forcing field datasets were stored on the CRAY, but the model decks and post-processing programs were developed and stored on the IBM front-end and model output was disposed to the front-end for transfer to IOSDL.

1 Files developed at the Robert Hooke Institute

1.1 On the IBM front-end (archived at IOSDL under ID 'BAC')

Decks

FINE DECK	Fine resolution run with flat bottom topography, a single island and created T, S fields.
FINEM DECK	Microtasked version of FINE DECK.
FSPIN DECK	Fine resolution run using SMFDEP, SMFTEM, SMFSAL fields - no open boundary and no winds.
FMSPIN DECK	Microtasked version of FSPIN DECK.

Fortran programs

PROC FORTRAN	Reads in output files from FSPIN DECK, re-orders them and writes them out using ASCOUT.
FINTOP FORTRAN	Reads in 1° median (smoothed) topography, SMDEPS, and interpolates to give a new 1/2° longitude x 1/4° latitude topography, SMFDEPS.
FTRAC FORTRAN	Creates fine resolution temperature and salinity datasets by interpolating SMTEMP, SMSALT (for topography SMDEPS) to give SMFTEM, SMFSAL (for topography SMFDEPS).
FMAP FORTRAN	Reads in fine resolution topography and produces a 'readable' map of it.

Job control files

FINE1 JOB	A general job to run the various fine resolution programs. This has both ordinary CFT77 and SEGLDR and that required for multitasking.

1.2 On the CRAY (archived at RAL)

Topography

SMFDEP	Fine resolution topography (interpolated from SMDEPS used for coarse resolution model).

Fields

BUFFTP BUFFSL	Temperature and salinity datasets used by fine resolution BUFFSL model.
WINDXF WINDYF	Annual mean Hellerman wind stress (duplicate copies of WINDX, WINDY used by coarse resolution model).
HELLERMANWINDSF	Monthly mean Hellerman wind stress (duplicate copy of HELLERMANWINDS2 used by coarse resolution model).

2. Files created after 1/10/88 and used during the main runs

2.1 On the IBM front-end (archived at IOSDL under ID 'BAC')

Decks

FAA DECK	Initial deck, used for runs FA41 - FA61 (model days 0 - 270).
FAB DECK	Test deck not used in main run.
FAC DECK	Used for runs FC1 - FC11 (model days 270 - 634). Changes include date handling and dynamic assignment of files.
FAD DECK	Used for runs FAD1 - FAD26 (model days 516 - 1759). Correction made to open boundary code. Partial re-run.
FAE DECK	Used for runs FAE27 - FAE34 (model days 1750 - 2200). Minor changes to deck to simplify and remove Cyber-specific code.
FAF DECK	Used for runs FAF35 - FAF63 (model days 2131 - 3256). Deck with microtasking and disk-striping to improve speed.
FAG DECK	Used for runs FAG64 - FAG71 (model days 1826 - 2191). Deck to re-run years 5 - 6 after discovery that the Levitus temperature used for relaxation was *in situ* temperature rather than potential temperature as assumed by the model. Annual mean wind forcing continued until day 2191.
FAH DECK	Used for runs FAH71- FAH88 (model days 3256 - 3652). Deck with code for biharmonic and harmonic friction.

FAI DECK	Used for runs FAI29 - FAI111 (model days 3256 - 5082). Deck compatible with UNICOS operating system. Microtasking and disk-striping removed. Eddy statistics code included.
FAK DECK	Used for runs FAK112 - FAK131A (model days 5082 - 5600). Deck used to output restart and eddy statistics every day for one month and at 10 day intervals subsequently.
FAL DECK	Used for runs FAL132 - FAL144 (model days 5520 - 5844). Deck to run model with increased friction near northern boundary in Indian Ocean only.

Job control files

Each of the above decks run under the COS operating system has a job control file, FAx JOB, where x is one of A - H. For running under the UNICOS operating system these were named autojcl job, auto2jcl job, auto3jcl job.

2.2 On the CRAY (archived at RAL)

Fortran programs

COXBASECODE	Model base code.
UPDOC	Copy of UPDOC FORTRAN to add updates to base code.
UPDOCBIN	UPDOC in binary code.
FINRESDBIN	Binary code for running fine resolution model.
FRAMLIB	Binary code for FRAM subroutine library.

Topography

SMFDEP	Fine resolution topography.

Fields

BUFFTP BUFFSL	Temperature and salinity datasets used by fine resolution model. (Levitus annual mean.)
BUFFPTP	Potential temperature dataset used by fine resolution model. (Modified Levitus annual mean.)
FSURFS FSURFT	Annual mean Levitus surface temperature and salinity datasets.
WINDXF WINDYF	Annual mean Hellerman wind stress.
HELLERMANWINDSF	Monthly mean Hellerman wind stress (duplicate copy of HELLERMANWINDS2 used by coarse resolution model).

3. Input and output files assigned in the model runs

3.1 Files assigned in the initial run

Input files

Fortran Unit No.	*File name*	
5	DATA	(standard input file)
7	SMFDEP	
8	BUFFTP	(buffered copy of 65)
9	BUFFSL	(buffered copy of 66)
10	DECK	
11	KONTRL	
12	KFLDS	
13	LABS1	
14	LABS2	
15	LABS3	
20	COXBASECODE	
65	SMFTEM1	
66	SMFSAL1	

Output files

Fortran Unit No.	*File name*
6	(standard output file)
18	£STATS (I/O statistics)
37	FRTLA1 (T sections at constant latitude)
38	FRSLA1 (S sections at constant latitude)
39	FRSTR1 (stream function)
50	LOSLICE (T,S,u,v sections at constant longitude)
54	DESLICE (T,S,u,v sections at constant depth
56	FRULA1 (u sections at constant latitude)
57	FRVLA1 (v sections at constant latitude)
62	FAENE (energetics)

The output data from Fortran units 37, 38, 50, 54, 56 and 57 mentioned in the table above were produced in preliminary test runs, but not stored. The only model field initially produced by subroutine 'ASCOUT' during the run was the stream function, at intervals of 10 model days.

3.2 Files on the CRAY under COS and UNICOS operating systems

The following table shows the name changes associated with the move to UNICOS. The old COS names are given and the corresponding directories and filenames under UNICOS.

Table 10

COS filename	*UNICOS directory*	*UNICOS filename (lower case)*
COXBASECODE	/atlas/framb/src	coxbasecode
UPDOC	"	updoc.f
	"	framlib.f
UPDOCBIN	/atlas/framb/bin	updoc.o
FRAMLIB	"	framlib.o
BUFFPTP	/atlas/framb/framdata	buffptp
BUFFSL	"	buffsl
FSURFS	"	fsurfs
FSURFT	"	fsurft
HELLERMANWINDF	"	hellerman
SMFDEP	"	smfdep
WINDXF	"	windxf
WINDYF	"	windyf

Note that the old COS files HELLERMANWINDS, WINDX and WINDY are the same as HELLERMANWINDSF, WINDXF AND WINDYF. As UNICOS allows multiple access to files, there is no need to duplicate these.

3.3 Files assigned under UNICOS

Input files

Fortran Unit No.	*File name*	
6	data	
10	deck	
11	kontrl	
12	kflds	
13	labs1	
14	labs2	
15	labs3	
20	coxbasecode	
60	smfdep	
63	windxf	
64	windyf	
65	hellerman	
66	fsurft	
67	fsurfs	
71	buffptp	(buffered copy of 61)
72	buffsl	(buffered copy of 62)
87	logfile	
88	runfile	

Output files

Fortran Unit No.	*File name*	
51	enexxxx	
52	fpxxxx	
53	ffxxxx	
54	fpxxxx	(for DPS)
55	ffxxxx	(for DPS)
56	velxxxx	(for NCW/KJR)
57	taxxxx	(for Tim Grose)
58	tbxxxx	(" " ")
92	eddy statistics	

APPENDIX III

STORAGE OF THE MODEL DATASETS

The FRAM restart datasets are stored on 3480 cartridge tapes attached to the CRAY and also copied to exabyte tape for transfer to IOSDL for analysis and display purposes. Because of the size of the fine resolution model, each restart dataset is stored on a single cartridge tape. Fortran programs were developed and stored on the IBM front-end at RAL to transfer to tape the data for one complete timestep plus the extra fields needed to enable a restart to be made before a forward timestep. In the standard format adopted for the FRAM data, this file starts with a header section made up of ASCII characters, followed by the main archive dataset written as binary images in the computer's floating point data format. Integers are transformed to floating point before archiving. On the cartridges stored at RAL, the binary format used is the Cray 64-bit (8 byte) floating point format. On the exabyte tapes, the format used is the 32-bit (4 byte) IEEE floating point format, used internally by the Sun computers and many other mini-computers (eg. Silicon Graphics).

When the model was restarted at day 3256 with biharmonic friction, changes were made to the tape format to include a 200 record header, the USTAR, VSTAR and pressure fields, and the snow and ice arrays (set to zero in main run). Tapes written after this are in the new format and data from year 6 onwards have been copied to new tapes in the enlarged format.

There is a slight difference in the format used to store the slab data for latitude rows JMT-2 and JMT-1 on cartridge tape and on exabyte, so that two sets of programs have been developed to create the archive datasets. The datasets on cartridge can be used to restart the FRAM model at a forward timestep.

The eddy statistics data were initially stored as a second file on the cartridge tape containing the restart data for the same timestep. Eddy statistics collected before day 4048 of the model run did not include any of the fields involving salinity. When the file was enlarged to include salinity arrays, this was no longer possible and the eddy statistics were then stored in groups of 10 on separate cartridge tapes. For consistency all fields are included on exabyte archive files, with missing data set to zero.

1. Files for processing the model output

These files are all archived at IOSDL.

1.1 Fortran programs on IBM front-end at RAL (under ID FRAMA unless otherwise stated)

EDLARGE FORTRAN: enlarges eddy statistics file to include salinity arrays (set to zero).

EXED FORTRAN: reads eddy statistics data (including salinity arrays) from disk and writes in IEEE format.

EXWRITE FORTRAN: translates restart data file created by F2DSKWR FORTRAN into IEEE format for trancfer to exabyte tape.

FCOPYD3 FORTRAN: reads the restart data file created by F3TPEWR FORTRAN and write in format consistent with that produced by F2DSKWR FORTRAN. This is the format needed for conversion to IEEE format for transfer to exabyte tape.

FCOPYA FORTRAN: reads the restart data file created by F3TPEWR FORTRAN and write in format consistent with that produced by F2DSKWR FORTRAN. This is the format needed for conversion to IEEE format for transfer to exabyte tape. (Under ID FRAMC.)

FCOPYD FORTRAN: reads the restart data file created by FDISKWR FORTRAN and writes with header and USTAR, VSTAR, pressure and sea ice arrays (set to zero). The T slabs needed for the open boundary calculations are stored as T(I), I = 1, IMTKMN2. (ie. 5874 blocks). Copies under IDs FRAMA, FRAMB.

FCOPYD2 FORTRAN: reads the restart data file created by FCOPYD FORTRAN and writes with the T slabs needed for the open boundary calculations stored as T(I), I = 1, NSLAX. (ie. 5877 blocks)

FCOPYD3 FORTRAN: Under ID FRAMA, this is the same as FCOPYA FORTRAN above.

FDISKRD FORTRAN: reads restart data file created by FDISKWR FORTRAN from disk and creates the five files needed to start the model.

FDISKWR FORTRAN: reads five restart data files in early form, and writes out in one file reducing the slab data to that needed to restart on a forward timestep. The complete TA slabs plus the slab incidental data from the T slabs are stored for rows J = 1, JMT plus the full T slabs for rows JMTM2 and JMTM1, needed for the open boundary calculations. The slabs are of length NSLAX, not the full buffer length NSLAB.

FXCDS FORTRAN: Under ID FRAMC, this is the same as EXWRITE FORTRAN above.

FXEDDY FORTRAN: Under ID FRAMC, this is the same as EXED FORTRAN above.

F2DSKRD FORTRAN: reads restart data file created by F2DSKRD FORTRAN from disk and forms five files needed to start the model.

F2DSKWR FORTRAN: reads five restart data files and writes to disk as one file. This version includes the header, USTAR, VSTAR and sea ice arrays. The pressure array is set to zero. The T slabs needed for the open boundary calculation are stored as T(I), I = 1, IMTKMN2.

F3DSKRD FORTRAN: reads restart data file created by F3TPEWR FORTRAN from disk and forms five files needed to start the model.

F3TPEWR FORTRAN: reads five restart data files and writes to disk as one. This version includes the header, USTAR, VSTAR, sea ice arrays and code for the pressure calculation. The T slabs needed for the open boundary code are stored as T(I), I = 1, NSLAX.

1.2 Execs on IBM front-end at RAL (under ID FRAMA unless otherwise stated)

EDDYRD EXEC: retrieves *faaedstats'day'* from tape and writes to */mainrun/faeds'day'*. (Under ID FRAMB.)

EDDYWR EXEC: writes */mainrun/faeds'day'* to tape as *faaedstats'day'*. (Under ID FRAMB).

EDLARGE EXEC: retrieves *faaedstats'day'* from tape, uses EDLARGE FORTRAN to add salinity arrays (set to zero) and copies to tape.

EDTOEX EXEC: retrieves *faaedstats'day'*, from tape, uses EXED FORTRAN to add header and write to VAX front-end in IEEE format for transfer to exabyte tape.

ENFILE EXEC: reads early restart data file, */compressed/FDATA'day'*, uses FCOPYD FORTRAN to add header and enlarge, and copies to */compressed/fastart'day'*.

ENLARGE EXEC: as ENFILE EXEC, but retrieves *faadataset'day'* from tape, uses FCOPYD FORTRAN and writes */compressed/fastart'day'*.

ENWRITE EXEC: as ENLARGE EXEC, but copies */compressed/fastart'day'* to tape as *faadataset'day'*.

FCOPYC EXEC: reads COS restart data file, *FAADATASET'day'*, from tape, uses FCOPYD3 FORTRAN and writes */compressed/fastart'day'*.

FCOPYC2 EXEC: reads COS restart data file, *FAADATASET'day'*, from tape, writes as */compressed/fastart'day'a*, uses FCOPYD2 FORTRAN to create */compressed/fastart'day'* (5877 blocks).

FCOPYD EXEC: reads */compressed/fastart'day'a*, uses FCOPYD FORTRAN and writes */compressed/fastart'day'*.

FCOPYD3 EXEC: reads */compressed/fastart'day'a*, uses FCOPYD3 FORTRAN and writes */compressed/fastart'day'*.

FDISKRD EXEC: calls FDISKRD FORTRAN and reads from compressed disk file

FDISKWR EXEC calls FDISKWR FORTRAN and writes compressed file to disk

FD2TAPE EXEC: copies */compressed/fastart'day'* to tape as *faadataset'day'*.

FD2TPB EXEC: copies */compressed/fastart'day'* to tape as *fbcdataset'day'*. (Under ID FRAMB).

FED2D EXEC: reads eddy statistics file, *faaedstats'day'*, from tape and copies to */mainrun/faeds'day'*. The same exec under ID FRAMB copies *fbcedstats'day'* to */mainrun/faeds'day'* [1]

FTAPERD EXEC: reads compressed data file from tape, calls FDISKRD FORTRAN.

FTAPEWR EXEC: calls FDISKWR FORTRAN and writes compressed file to tape

FTAPE2D EXEC: copies any restart data file, *faadataset'day'*, from tape to */compressed/fastart'day'*.

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[1] For sea ice run.

FTPB2D EXEC:	copies restart data file, *fabdataset'day'*, from tape to */compressed/fastart'day'*.
TAPEWR EXEC:	writes any file to tape. (Under ID FRAMB.)
TFETCH EXEC:	fetches any file from tape and places in sub-directory *testframa*, keeping same file name.

2. TAPE DETAILS

The following 3480 cartridge tapes have been allocated to the FRAM project and are stored at RAL:

800671 - 800685	804352 - 804401
800873 - 800907	804414 - 804463
801376 - 801425	804912 - 804941
801715 - 801764	805292 - 805341
802845 - 802894	805543 - 805592
804140 - 804189	805794 - 805843
804245 - 804254	806155 - 806204
804256 - 804295	806206 - 806255
	806267 - 806316
X01221 - X01230 [2]	AA0250 - AA0254 [2]

Tapes 800679 - 800684 were written as unlabelled tapes. All other tapes have IBM standard labels. Tapes 804293-4, 805575, 805834-43 were issued to Imperial College and 804295 was used by RAL (NEJ). Exabyte tapes 8M0060 - 8M0061 were supplied to take data to Hamburg.

The following tape has backup copies of files used by the fine resolution model:

Tape numbers 800906 / 800907

File sequence	*Filename*
1	SMFDEP
2	BUFFTP
3	BUFFSL
4	HELLERMANWINDSF
5	WINDXF
6	WINDYF
13	BUFFPTP
14	COXBASECODE

[2] Brought from Hamburg with data from sea ice run.

2.1 Restart datasets

The restart data are stored on the following tapes:

Year 0

Tape number	*Filename*	
800679	FAARESTART001	Jan 2
801376	FAADATASET001	(second copy)
800680	FAARESTART020	Jan 21
801377	FAADATASET020	(second copy)
800681	FAARESTART030	Jan 31
800682	FAARESTART040	Feb 10
800683	FAARESTART070	Mar 12
800684	FAARESTART100	Apr 11
800685	FAARESTART130	May 11
800873	FAADATASET150	May 31
800874	FAADATASET180	Jun 30
801378	FAADATASET180	(second copy)
800875	FAADATASET210	Jul 30
800876	FAADATASET240	Aug 29
800877	FAADATASET270	Sep 28
800878	FAADATASET273	Oct 1
800879	FAADATASET304	Nov 1
800880	FAADATASET334	Dec 1

Year 1

Tape number	*Filename*	
800881	FAADATASET365	Jan 1
801379	FAADATASET365	(second copy)
800882	FAADATASET396	Feb 1
800883	FAADATASET424	Mar 1
800884	FAADATASET455	Apr 1
800885	FAADATASET485	May 1
800886	FAADATASET516	Jun 1
800887	FAADATASET546	Jul 1
800896	FAADATASET546	(re-run)
801380	FAADATASET546	(second copy)
800897	FAADATASET577	Aug 1 (re-run)
800888	FAADATASET608	Sep 1
800895	FAADATASET630	Sep 23
800889	FAADATASET638	Oct 1
800898	FAADATASET669	Nov 1
800899	FAADATASET699	Dec 1

Year 2

Tape number	*Filename*	
800900	FAADATASET730	Jan 1
801381	FAADATASET730	(second copy)
800901	FAADATASET761	Feb 1
800902	FAADATASET789	Mar 1
800903	FAADATASET820	Apr 1
800904	FAADATASET850	May 1
800905	FAADATASET881	Jun 1
801382	FAADATASET911	Jul 1
801393	FAADATASET1003	Oct 1
801394	FAADATASET1034	Nov 1
801395	FAADATASET1064	Dec 1 (1 slab only)

Year 3

Tape number	*Filename*	
801396	FAADATASET1095	Jan 1
801383	FAADATASET1095	
801397	FAADATASET1126	Feb 1
801398	FAADATASET1155	Mar 1
801399	FAADATASET1186	Apr 1
801400	FAADATASET1216	May 1
801401	FAADATASET1247	Jun 1
801402	FAADATASET1277	Jul 1
801384	FAADATASET1277	
801403	FAADATASET1308	Aug 1
801404	FAADATASET1339	Sep 1
801405	FAADATASET1369	Oct 1
801406	FAADATASET1400	Nov 1
801407	FAADATASET1430	Dec 1

Year 4

Tape number	*Filename*	
801408	FAADATASET1461	Jan 1
801385	FAADATASET1461	
801409	FAADATASET1492	Feb 1
801410	FAADATASET1520	Mar 1
801411	FAADATASET1551	Apr 1
801412	FAADATASET1581	May 1
801413	FAADATASET1612	Jun 1
801414	FAADATASET1642	Jul 1
801386	FAADATASET1642	
801415	FAADATASET1673	Aug 1
801416	FAADATASET1704	Sep 1
801417	FAADATASET1734	Oct 1
801418	FAADATASET1765	Nov 1
801419	FAADATASET1795	Dec 1

Year 4 (new format)

Tape number	*Filename*	
804177	FAADATASET1461	Jan 1
804178	FAADATASET1492	Feb 1
804179	FAADATASET1520	Mar 1
804180	FAADATASET1551	Apr 1
804181	FAADATASET1581	May 1
804182	FAADATASET1612	Jun 1
804183	FAADATASET1642	Jul 1
804184	FAADATASET1673	Aug 1
804185	FAADATASET1704	Sep 1
804186	FAADATASET1734	Oct 1
804187	FAADATASET1765	Nov 1
804188	FAADATASET1795	Dec 1

Year 5

Tape number	*Filename*	
801420	FAADATASET1826	Jan 1
801387	FAADATASET1826	
801421	FAADATASET1857	Feb 1
801422	FAADATASET1885	Mar 1
801423	FAADATASET1916	Apr 1
801424	FAADATASET1946	May 1
801425	FAADATASET1977	Jun 1
801715	FAADATASET2007	Jul 1
801388	FAADATASET2007	
801716	FAADATASET2038	Aug 1
801717	FAADATASET2069	Sep 1
801718	FAADATASET2099	Oct 1
801719	FAADATASET2130	Nov 1
801720	FAADATASET2160	Dec 1

Year 5 (re-run with potential temperature)

Tape number	*Filename*	
801760	FAADATASET1826	Jan 1
802849	FAADATASET1826	(second copy)
801757	FAADATASET1857	Feb 1
801758	FAADATASET1885	Mar 1
801759	FAADATASET1916	Apr 1
802850	FAADATASET1946	May 1
802851	FAADATASET1977	Jun 1
802852	FAADATASET2007	Jul 1
802853	FAADATASET2038	Aug 1
802854	FAADATASET2069	Sep 1
802855	FAADATASET2099	Oct 1
802856	FAADATASET2130	Nov 1
802857	FAADATASET2160	Dec 1

Year 5 (re-run in new format)

Tape number	*Filename*	
804140	FAADATASET1826	Jan 1
804141	FAADATASET1857	Feb 1
804142	FAADATASET1885	Mar 1
804143	FAADATASET1916	Apr 1
804144	FAADATASET1946	May 1
804145	FAADATASET1977	Jun 1
804146	FAADATASET2007	Jul 1
804147	FAADATASET2038	Aug 1
804148	FAADATASET2069	Sep 1
804149	FAADATASET2099	Oct 1
804150	FAADATASET2130	Nov 1
804151	FAADATASET2160	Dec 1

Year 6

Tape number	*Filename*	
801721	FAADATASET2191	Jan 1
801389	FAADATASET2191	(second copy)
802858	FAADATASET2191	Jan 1
	(end of re-run with potential temp.)	
801722	FAADATASET2222	Feb 1
801723	FAADATASET2250	Mar 1
801724	FAADATASET2281	Apr 1
801725	FAADATASET2311	May 1
801727	FAADATASET2372	Jul 1
801390	FAADATASET2372	(second copy)
801728	FAADATASET2403	Aug 1
801729	FAADATASET2434	Sep 1
801730	FAADATASET2464	Oct 1
801731	FAADATASET2495	Nov 1
801732	FAADATASET2525	Dec 1

Year 6 (new format)

Tape number	*Filename*	
804152	FAADATASET2191	Jan 1 (pot. temp.)
804401	FAADATASET2191	Jan 1 (pressure)
804153	FAADATASET2222	Feb 1
804154	FAADATASET2250	Mar 1
804155	FAADATASET2281	Apr 1
804156	FAADATASET2311	May 1
801726	FAADATASET2342	Jun 1
804157	FAADATASET2342	Jun 1
804158	FAADATASET2372	Jul 1
804159	FAADATASET2403	Aug 1
804160	FAADATASET2434	Sep 1
804161	FAADATASET2464	Oct 1
804162	FAADATASET2495	Nov 1
804163	FAADATASET2525	Dec 1

Year 7

Tape number	*Filename*	
801733	FAADATASET2556	Jan 1
801391	FAADATASET2556	
801734	FAADATASET2587	Feb 1
801735	FAADATASET2616	Mar 1
801736	FAADATASET2647	Apr 1
801737	FAADATASET2677	May 1
801738	FAADATASET2708	Jun 1
801739	FAADATASET2738	Jul 1
801392	FAADATASET2738	
801740	FAADATASET2769	Aug 1
801741	FAADATASET2800	Sep 1
801742	FAADATASET2830	Oct 1
801743	FAADATASET2861	Nov 1
801744	FAADATASET2891	Dec 1

Year 7 (new format)

Tape number	*Filename*	
804164	FAADATASET2556	Jan 1
804165	FAADATASET2587	Feb 1
804166	FAADATASET2616	Mar 1
804167	FAADATASET2647	Apr 1
804168	FAADATASET2677	May 1
804169	FAADATASET2708	Jun 1
804170	FAADATASET2738	Jul 1
804171	FAADATASET2769	Aug 1
804172	FAADATASET2800	Sep 1
804173	FAADATASET2830	Oct 1
804174	FAADATASET2861	Nov 1
804175	FAADATASET2891	Dec 1

Year 8

Tape number	*Filename*	
801745	FAADATASET2922	Jan 1
801746	FAADATASET2953	Feb 1
801747	FAADATASET2981	Mar 1
801748	FAADATASET3012	Apr 1
801749	FAADATASET3042	May 1
801750	FAADATASET3073	Jun 1
801751	FAADATASET3103	Jul 1
801752	FAADATASET3134	Aug 1
801753	FAADATASET3165	Sep 1
801754	FAADATASET3195	Oct 1
801761	FAADATASET3210	(original temp)
801762	FAADATASET3210	(potential temp)
801755	FAADATASET3226	Nov 1
801756	FAADATASET3256	Dec 1

Year 8 (new format)

Tape number	*Filename*	
804176	FAADATASET2922	Jan 1
802873	FAADATASET2953	Feb 1
802874	FAADATASET2981	Mar 1
802875	FAADATASET3012	Apr 1
802876	FAADATASET3042	May 1
802877	FAADATASET3073	Jun 1
802878	FAADATASET3103	Jul 1
802879	FAADATASET3134	Aug 1
802880	FAADATASET3165	Sep 1
802881	FAADATASET3195	Oct 1
802882	FAADATASET3226	Nov 1
802859	FAADATASET3256	Dec 1 (new BH, BM)
802883	FAADATASET3256	Dec 1

Year 9 (new format)

Tape number	*Filename*	
802860	FAADATASET3287	Jan 1
802861	FAADATASET3318	Feb 1
802862	FAADATASET3377	Mar 1
802863	FAADATASET3377	Apr 1
802864	FAADATASET3408	May 1
802865	FAADATASET3438	Jun 1
802866	FAADATASET3468	Jul 1
802867	FAADATASET3499	Aug 1
802868	FAADATASET3530	Sep 1
802869	FAADATASET3562	Oct 3
802870	FAADATASET3591	Nov 1
802871	FAADATASET3621	Dec 1

Year 9 (re-run)

Tape number	*Filename*	
802884	faadataset3287	Jan 1
802885	faadataset3318	Feb 1
802886	faadataset3377	Apr 1 (Mar 1 o/w)
802887	faadataset3377	Apr 1
802888	faadataset3407	May 1
802889	faadataset3439	Jun 2 (not EB)
802890	faadataset3468	Jul 1
802891	faadataset3499	Aug 1
802892	faadataset3530	Sep 1
802893	faadataset3562	Oct 3
802894	faadataset3591	Nov 1
802847	faadataset3621	Dec 1

Year 10

Tape number	*Filename*	
802848	FAADATASET3652	Jan 1
802872	faadataset3652	Jan 1
804245	faadataset3683	Feb 1
804246	faadataset3711	Mar 1
804247	faadataset3742	Apr 1
804248	faadataset3772	May 1
804249	faadataset3803	Jun 1
804250	faadataset3833	Jul 1
804251	faadataset3864	Aug 1
804252	faadataset3895	Sep 1
804253	faadataset3925	Oct 1
804254	faadataset3956	Nov 1
804256	faadataset3986	Dec 1

Year 11

Tape number	*Filename*	
804257	faadataset4017	Jan 1
804258	faadataset4048	Feb 1
804259	faadataset4077	Mar 1
804260	faadataset4108	Apr 1
804261	faadataset4138	May 1
804263	faadataset4169	Jun 1
804264	faadataset4199	Jul 1
804265	faadataset4230	Aug 1
804266	faadataset4261	Sep 1
804267	faadataset4291	Oct 1
804268	faadataset4322	Nov 1
804269	faadataset4352	Dec 1

Year 12

Tape number	*Filename*	
804270	faadataset4383	Jan 1
804271	faadataset4414	Feb 1
804272	faadataset4442	Mar 1
804273	faadataset4473	Apr 1
804274	faadataset4503	May 1
804275	faadataset4534	Jun 1
804276	faadataset4564	Jul 1
804277	faadataset4595	Aug 1
804278	faadataset4626	Sep 1
804279	faadataset4656	Oct 1
804280	faadataset4687	Nov 1
804281	faadataset4717	Dec 1

Year 13

Tape number	*Filename*	
804282	faadataset4748	Jan 1
804284	faadataset4779	Feb 1
804285	faadataset4807	Mar 1
804286	faadataset4838	Apr 1
804287	faadataset4868	May 1
804288	faadataset4899	Jun 1
804289	faadataset4900	Jun 2
804290	faadataset4910	Jun 12
804291	faadataset4920	Jun 22
804292	faadataset4929	Jul 1
804353	faadataset4930	Jul 2
804354	faadataset4940	Jul 12
804355	faadataset4950	Jul 22
804356	faadataset4960	Aug 1
804357	faadataset4970	Aug 11
804358	faadataset4980	Aug 21
804359	faadataset4990	Aug 31

Year 13 (continued))

Tape number	*Filename*	
804360	faadataset4991	Sep 1
804361	faadataset5000	Sep 10
804362	faadataset5010	Sep 20
804363	faadataset5020	Sep 30
804364	faadataset5021	Oct 1
804365	faadataset5030	Oct 10
804366	faadataset5040	Oct 20
804367	faadataset5050	Oct 30
804368	faadataset5052	Nov 1
804370	faadataset5060	Nov 9
804371	faadataset5070	Nov 19
804372	faadataset5080	Nov 29
804373	faadataset5082	Dec 1
804374	faadataset5083	Dec 2
804375	faadataset5084	Dec 3
804376	faadataset5085	Dec 4
804377	faadataset5086	Dec 5
804378	faadataset5087	Dec 6
804380	faadataset5088	Dec 7
804381	faadataset5089	Dec 8
804382	faadataset5090	Dec 9
804383	faadataset5091	Dec 10
804384	faadataset5092	Dec 11
804385	faadataset5093	Dec 12
804386	faadataset5094	Dec 13
804387	faadataset5095	Dec 14
804388	faadataset5096	Dec 15
804389	faadataset5097	Dec 16
804391	faadataset5098	Dec 17
804392	faadataset5099	Dec 18
804393	faadataset5100	Dec 19
804394	faadataset5101	Dec 20
804395	faadataset5102	Dec 21
804396	faadataset5103	Dec 22
804397	faadataset5104	Dec 23
804398	faadataset5105	Dec 24
804399	faadataset5106	Dec 25
804414	faadataset5107	Dec 26
804415	faadataset5108	Dec 27
804416	faadataset5109	Dec 28
804417	faadataset5110	Dec 29
804418	faadataset5111	Dec 30
804419	faadataset5112	Dec 31

Year 14

Tape number	*Filename*	
804420	faadataset5113	Jan 1
804422	faadataset5120	Jan 8
804423	faadataset5130	Jan 18
804424	faadataset5140	Jan 28
804425	faadataset5144	Feb 1
804426	faadataset5150	Feb 7
804227	faadataset5160	Feb 17
804228	faadataset5170	Feb 27
804229	faadataset5172	Mar 1
804230	faadataset5180	Mar 9
804331	faadataset5190	Mar 19
804332	faadataset5200	Mar 29
804333	faadataset5203	Apr 1
804334	faadataset5210	Apr 8
804436	faadataset5220	Apr 18
804437	faadataset5230	Apr 28
804438	faadataset5233	May 1
804439	faadataset5240	May 8
804440	faadataset5250	May 18
804441	faadataset5260	May 28
804442	faadataset5264	Jun 1
804443	faadataset5270	Jun 7
804444	faadataset5280	Jun 17
804446	faadataset5290	Jun 27
804447	faadataset5294	Jul 1
804448	faadataset5300	Jul 7
804449	faadataset5310	Jul 17
804450	faadataset5320	Jul 27
804451	faadataset5325	Aug 1
804452	faadataset5330	Aug 6
804453	faadataset5340	Aug 16
804454	faadataset5350	Aug 26
804456	faadataset5356	Sep 1
804457	faadataset5360	Sep 5
804458	faadataset5370	Sep 15
804459	faadataset5380	Sep 25

Year 14 (continued)

Tape number	*Filename*	
804460	faadataset5386	Oct 1
804461	faadataset5390	Oct 5
804462	faadataset5400	Oct 15
804463	faadataset5410	Oct 25
804913	faadataset5417	Nov 1
804914	faadataset5420	Nov 4
804915	faadataset5430	Nov 14
804916	faadataset5440	Nov 24
804917	faadataset5447	Dec 1
804918	faadataset5450	Dec 7
804919	faadataset5460	Dec 17
804920	faadataset5470	Dec 27

Year 15

Tape number	*Filename*	
804921	faadataset5478	Jan 1
804924	faadataset5480	Jan 3
804925	faadataset5490	Jan 13
804926	faadataset5500	Jan 23
804927	faadataset5509	Feb 1
804928	faadataset5510	Feb 2
804929	faadataset5520	Feb 12
804930	faadataset5530	Feb 22
805544	fabdataset5530	
804931	faadataset5538	Mar 1
805545	fabdataset5538	
804932	faadataset5540	Mar 3
805546	fabdataset5540	
804933	faadataset5550	Mar 13
805547	fabdataset5550	
804934	faadataset5560	Mar 23
805548	fabdataset5560	
804935	faadataset5569	Apr 1
805549	fabdataset5569	
804936	faadataset5570	Apr 2
805550	fabdataset5570	

Year 15 (continued)

Tape number	*Filename*	
804937	faadataset5580	Apr 12
805551	fabdataset5580	
804938	faadataset5590	Apr 22
805552	fabdataset5590	
804939	faadataset5599	May 1
805553	fabdataset5599	
804440	faadataset5600	May 2
805554	fabdataset5600	
805556	fabdataset5610	May 12
805557	fabdataset5620	May 22
805558	fabdataset5630	Jun 1
805559	fabdataset5640	Jun 11
805560	fabdataset5650	Jun 21
805561	fabdataset5660	Jul 1
805562	fabdataset5670	Jul 11
805563	fabdataset5680	Jul 21
805564	fabdataset5690	Jul 31
805565	fabdataset5691	Aug 1
805567	fabdataset5700	Aug 10
805568	fabdataset5710	Aug 20
805569	fabdataset5720	Aug 30
805570	fabdataset5722	Sep 1
805571	fabdataset5730	Sep 9
805572	fabdataset5740	Sep 19
805573	fabdataset5750	Sep 29
805574	fabdataset5752	Oct 1
805576	fabdataset5760	Oct 9
805577	fabdataset5770	Oct 19
805579	fabdataset5780	Oct 29
805580	fabdataset5783	Nov 1
805581	fabdataset5790	Nov 8
805582	fabdataset5800	Nov 18
805583	fabdataset5810	Nov 28
805584	fabdataset5813	Dec 1
805585	fabdataset5820	Dec 8
805586	fabdataset5830	Dec 18
805587	fabdataset5840	Dec 28

Year 16

Tape number	*Filename*	
805588	fabdataset5844	Jan 1

2.2 Eddy statistics

The eddy statistics were initially stored in file sequence 2 of the tape containing the corresponding restart dataset:

Tape number	*Filename*
802848	faaedstats3652
804249	faaedstats3803
804250	faaedstats3833
804251	faaedstats3864
804252	faaedstats3895
804253	faaedstats3925
804254	faaedstats3964
804256	faaedstats3986
804257	faaedstats4017
804258	faaedstats4048

When the eddy statistics were extended to include salinity, they were stored in sets of 10 on separate tapes:

Tape Number 804923 (including salinity arrays set to zero)

File sequence	*Filename*
1	faaedstats3652
2	faaedstats3683
3	faaedstats3711
4	faaedstats3742

Tape Number 804262

File sequence	*Filename*
1	faaedstats4077
2	faaedstats4108
3	faaedstats4138
4	faaedstats4169
5	faaedstats4199
6	faaedstats4230
7	faaedstats4261
8	faaedstats4291
9	faaedstats4322
10	faaedstats4352

Tape Number 804189

File sequence	*Filename*
1	faaedstats4383
2	faaedstats4415 [3]
3	faaedstats4442
4	faaedstats4473
5	faaedstats4503
6	faaedstats4534
7	faaedstats4564
8	faaedstats4595
9	faaedstats4626
10	faaedstats4656

Tape Number 804283

File sequence	*Filename*
1	faaedstats4687
2	faaedstats4717
3	faaedstats4748
4	faaedstats4779
5	faaedstats4807
6	faaedstats4838
7	faaedstats4868
8	faaedstats4899
9	faaedstats4900
10	faaedstats4910

Tape Number 804352

File sequence	*Filename*
1	faaedstats4920
2	faaedstats4929
3	faaedstats4930
4	faaedstats4940
5	faaedstats4950
6	faaedstats4960
7	faaedstats4970
8	faaedstats4980
9	faaedstats4990
10	faaedstats4991

3. Eddy statistics summaries for day 4414.

Tape Number 804369

File sequence	*Filename*
1	faaedstats5000
2	faaedstats5010
3	faaedstats5020
4	faaedstats5021
5	faaedstats5030
6	faaedstats5040
7	faaedstats5050
8	faaedstats5052
9	faaedstats5060
10	faaedstats5070

Tape Number 804379

File sequence	*Filename*
1	faaedstats5080
2	faaedstats5082
3	faaedstats5083
4	faaedstats5084
5	faaedstats5085
6	faaedstats5086
7	faaedstats5087
8	faaedstats5088
9	faaedstats5089
10	faaedstats5090

Tape Number 804390

File sequence	*Filename*
1	faaedstats5091
2	faaedstats5092
3	faaedstats5093
4	faaedstats5094
5	faaedstats5095
6	faaedstats5096
7	faaedstats5097
8	faaedstats5098
9	faaedstats5099
10	faaedstats5100

Tape Number 804400

File sequence	*Filename*
1	faaedstats5101
2	faaedstats5102
3	faaedstats5103
4	faaedstats5104
5	faaedstats5105
6	faaedstats5106
7	faaedstats5107
8	faaedstats5108
9	faaedstats5109
10	faaedstats5110

Tape Number 804421

File sequence	*Filename*
1	faaedstats5111
2	faaedstats5112
3	faaedstats5113
4	faaedstats5120
5	faaedstats5130
6	faaedstats5140
7	faaedstats5144
8	faaedstats5150
9	faaedstats5160
10	faaedstats5170

Tape Number 804435

File sequence	*Filename*
1	faaedstats5172
2	faaedstats5180
3	faaedstats5190
4	faaedstats5200
5	faaedstats5203
6	faaedstats5210
7	faaedstats5220
8	faaedstats5230
9	faaedstats5233
10	faaedstats5240

Tape Number 804445

File sequence	*Filename*
1	faaedstats5250
2	faaedstats5260
3	faaedstats5264
4	faaedstats5270
5	faaedstats5280
6	faaedstats5290
7	faaedstats5294
8	faaedstats5300
9	faaedstats5310
10	faaedstats5320

Tape Number 804455

File sequence	*Filename*
1	faaedstats5325
2	faaedstats5330
3	faaedstats5340
4	faaedstats5350
5	faaedstats5356
6	faaedstats5360
7	faaedstats5370
8	faaedstats5380
9	faaedstats5386
10	faaedstats5390

Tape Number 804912

File sequence	*Filename*
1	faaedstats5400
2	faaedstats5410
3	faaedstats5417
4	faaedstats5420
5	faaedstats5430
6	faaedstats5440
7	faaedstats5447
8	faaedstats5450
9	faaedstats5460
10	faaedstats5470

Tape Number 804922

File sequence	*Filename*
1	faaedstats5478
2	faaedstats5480
3	faaedstats5490
4	faaedstats5500
5	faaedstats5509
6	faaedstats5510
7	faaedstats5520
8	faaedstats5530
9	faaedstats5538
10	faaedstats5540

Tape Number 804941

File sequence	*Filename*
1	faaedstats5550
2	faaedstats5560
3	faaedstats5569
4	faaedstats5570
5	faaedstats5580
6	faaedstats5590
7	faaedstats5599
8	faaedstats5600

Tape Number 805543

File sequence	*Filename*
1	fabedstats5530
2	fabedstats5538
3	fabedstats5540
4	fabedstats5550
5	fabedstats5560
6	fabedstats5569
7	fabedstats5570
8	fabedstats5580
9	fabedstats5590
10	fabedstats5599

Tape Number 805555

File sequence	*Filename*
1	fabedstats5600
2	fabedstats5610
3	fabedstats5629
4	fabedstats5630
5	fabedstats5640
6	fabedstats5650
7	fabedstats5660
8	fabedstats5670
9	fabedstats5680
10	fabedstats5690

Tape Number 805566

File sequence	*Filename*
1	fabedstats5691
2	fabedstats5700
3	fabedstats5710
4	fabedstats5720
5	fabedstats5722
6	fabedstats5730
7	fabedstats5740
8	fabedstats5750
9	fabedstats5752
10	fabedstats5760

Tape Number 805578

File sequence	*Filename*
1	fabedstats5770
2	fabedstats5780
3	fabedstats5783
4	fabedstats5790
5	fabedstats5800
6	fabedstats5810
7	fabedstats5813
8	fabedstats5820
9	fabedstats5830
10	fabedstats5840

Tape Number 805589

File sequence	*Filename*
1	fabedstats5844

Brook Road, Wormley, Godalming
Surrey, GU8 5UB,
United Kingdom
Telephone +44 (0) 428-684141
Facsimile +44 (0) 428-683066
Telex 858833 OCEANS G

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Research
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