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The NMC Operational Global Energy Program

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The NMC Operational Global Energy Program

I. Introduction

Throughout the years, a need has been recognized by many groups within NOAA for numerical information on the "state" of the atmospheric general circulation as delineated by the synoptic analyses and/or numerical forecasts. For example, such data can be utilized in evaluating forecast techniques, determining the effects of various data inputs to the analyses and monitoring for perturbations against the norm. Ultimately, it was decided that one measure that could fulfill the above requirements was the estimate of various terms in the energy budget of the atmosphere along with certain basic parameters of the circulation that enter into the calculations. With the implementation of the global analysis scheme at NMC in late 1974, it was decided to include these calculations within each computational cycle, both 0000Z and 1200Z.

It is worth noting that the availability of the global analyses offered two significant advantages over previous analyses: the first is that as the analyses have a direct output of temperature and wind, no assumptions of geostrophy have to be included and the second is that the global analyses allow the computations to be extended not only into the Tropics, but also the Southern Hemisphere where information of this type has been very sparse.

At the same time, as the results from the computations are considered to be operational products, it was decided to archive them on the 36-day rotating disc file. In this manner, any group with disc access could obtain the desired information directly. For continuing archival, the daily data are retrieved at the end of each month, the monthly averages and standard deviations are computed and the complete file is retained on magnetic tape.

The purpose of this note is to describe the terms in the energy balance that are computed, the techniques of calculation, the output formats, and finally the procedures of disc access.

II. Energy Equations

A. At this point, it is convenient to use symbolic notation to denote the four equations pertinent to the energy budget as considered here:

$$(1)\quad \frac{\partial \text{AƵ}}{\partial t} = \text{BAƵ}\phi_s + \text{BAƵP}_1 + \text{BAƵP}_2 - \text{C(AƵ,AE)} - \text{C(AƵ,KƵ)} + \text{GƵ}$$

$$(2)\quad \frac{\partial \text{AE}}{\partial t} = \text{BAE}\phi_s + \text{BAEP}_1 + \text{BAEP}_2 + \text{C(AƵ,AE)} - \text{C(AE,KE)} + \text{GE}$$

$$(3)\quad \frac{\partial \text{KƵ}}{\partial t} = \text{BKƵ}_s + \text{BKƵP}_1 + \text{BKZP}_2 + \text{C(KE,KƵ)} + \text{B}\phi\text{Ƶ}_s + \text{B}\phi\text{ƵP}_1 + \text{B}\phi\text{ƵP}_2 + \text{C(AƵ,KƵ)} - \text{DƵ}$$

$$(4)\quad \frac{\partial \text{KE}}{\partial t} = \text{BKE}\phi_s + \text{BKEP}_1 + \text{BKEP}_2 - \text{C(KE,KƵ)} + \text{B}\phi\text{E}_s + \text{B}\phi\text{EP}_1 + \text{B}\phi\text{EP}_2 + \text{C(AE,KE)} - \text{DE}$$

where AƵ and AE are the zonal and eddy available potential energy and KƵ and KE are the zonal kinetic and eddy kinetic energy respectively. The terms beginning with the letter B represent boundary terms, those that begin with C are energy conversions between the parameters within the parentheses, G terms represent energy generation and D frictional dissipation. Thus $\text{BAZ}\phi_s$ represents the meridional flux of zonal available potential energy through the latitudinal boundary; BAƵP_1 is the flux of zonal available potential energy through the pressure surface P_1; C(AƵ,AE) is the conversion of energy between zonal available and eddy available potential energy, and GƵ is the generation of zonal available potential energy by diabatic processes. The terms involving BφEP and BφƵP are boundary terms also, but are of a different nature than the others. These terms represent a form of pressure-work at the boundaries and have been shown to be significantly greater than the BKEP and BKƵP terms.

While the above represents a virtually complete set of equations required for balance, in practice we are not able, at this time, to estimate several of the terms. For example, the generation and frictional dissipation terms require information that is simply not available. In addition, vertical motions are presently not analyzed and, consequently, all terms that require knowledge of this term are omitted as well. It is hoped that these terms can be included in the future. Finally, certain terms have been shown in previous investigations to be much smaller than the others and have not been considered here.

After all the above simplifications are included, the resultant terms of the energy equations that we consider are: AƵ, AE, KƵ, KE, C(AƵ,AE), C(KE, KƵ), and BφEP. The manner of inclusion of the BφEP term without calculation of the vertical motion will be discussed below.

B. <u>Definition of Symbols</u>

Throughout this note, all symbols will retain their usual meteorological convention and we will concentrate here on the definition of the operators employed.

$[S]$ = average around a latitude or zonal average = $\frac{1}{2\pi}\int_0^{2\pi} S d\lambda$

$S^* = S - [S]$ = departure of S at any point from the zonal average

$\overline{S}$ = areal average = $\frac{1}{(1-\sin\phi_s)}\int_{\phi_s}^{\pi/2} [S] \cos\phi d\phi$

$S'' = [S] - \overline{S}$ = departure of the zonal average from the areal average.

C. Parameter Definitions

$$AZ = \frac{R}{2}\frac{1}{P_o^{\kappa}} \frac{P^{\kappa-1}\,\overline{\theta''^2}}{-\frac{\overline{\partial\theta}}{\partial P}}$$

$$AE = \frac{R}{2}\frac{1}{P_o^{\kappa}} \frac{P^{\kappa-1}\,\overline{[\theta^{*2}]}}{-\frac{\overline{\partial\theta}}{\partial P}}$$

$$KZ = \tfrac{1}{2}\left(\overline{[u]^2} + \overline{[v]^2}\right)$$

$$KE = \tfrac{1}{2}\,\overline{[u^{*2} + v^{*2}]}$$

$$C(AZ,AE) = -\frac{R}{a\,P_o^{\kappa}} \frac{\overline{P^{\kappa-1}[v^*\theta^*]\frac{\partial\theta''}{\partial\phi}}}{-\frac{\overline{\partial\theta}}{\partial P}}$$

$$C(KE,KZ) = \frac{1}{a}\left(\overline{\cos\phi\,[u^*v^*]\frac{\partial}{\partial\phi}([u]/\cos\phi)} + \overline{[v^{*2}]\,\frac{\partial[v]}{\partial\phi}} - \overline{\tan\phi\,[v]\,[u^{*2}]}\right)$$

The term BϕEP is determined at 10 KPA (100 mb) only and is calculated utilizing the approximation of Miller and Johnson* such that:

$$B\phi EP_{10KPA} = [u] \frac{f}{g} \frac{[v^*\theta^*]}{\frac{\partial\theta}{\partial P}}$$

where a negative value of BϕEP represents a transfer of energy from the troposphere to the stratosphere.

III. Computational Techniques

A. Input of Parameters

The winds and temperature (u, v, T) for the energy calculations are normally taken from the final analysis file in strip form (&&SPASMOUT). This data is at 2.5° latitude-longitude intervals, at the mandatory pressure levels. For further description of the data format, see "For the Record", P. Chase, January 2, 1974. (Addendum I.)

In order to be able to calculate the energies from data in other formats, codes are available from the authors of this note to convert some formats to the required format. They are:

1) 65 x 65 polar stereographic data at mandatory levels to latitude longitude data at mandatory levels.

2) latitude-longitude data at mandatory levels to strip form (by latitude at mandatory levels).

B. Method of Calculation

Section II gave the definitions and equations appropriate to energy calculations. This section describes the approximate forms actually used by

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*Miller, A. J. and K. W. Johnson, 1970: On the interaction between the stratosphere and troposphere during the warming of December 1967-January 1968. Q.J.R.M.S., 95, 24-31.

the energy code. The forms are:

$$\text{zonal average:} \quad [S] \approx \frac{1}{N}\sum_{i=1}^{N} S_i$$

where S_i is a variable defined at a particular pressure level and given at N evenly spaced points along a latitude circle. As before

$$S^* \equiv S - [S] \ .$$

The area average is approximated by

$$\overline{S} \approx \frac{1}{\sin\phi_n - \sin\phi_s} \sum_{j=1}^{M} \tfrac{1}{2}\left([S]_j + [S]_{j+1}\right) \left(\cos \tfrac{1}{2}(\phi_j+\phi_{j+1})\right) (\phi_{j+1}-\phi_j)$$

where M+1 is the number of evenly spaced points in latitude between the latitudes ϕ_s and ϕ_n. We define

$$S'' \equiv [S] - \overline{S}$$

S'' represents the negative of the difference of the zonal average from the areal average. Naturally, since the areal average depends upon the area used, so does S''. Where possible, hemispheric averages are used for $\overline{S}$.

Finally, vertical integrals are approached as follows:

$$\int_{p_1}^{p_2} \overline{S}\,\frac{dp}{g} \approx \sum_{k=k_1}^{k_2-1} \tfrac{1}{2}\left(\overline{S}_k + \overline{S}_{k+1}\right)\frac{p_{k+1} - p_k}{g}$$

where k is a vertical index and $p(k_1) = p_1$ and $p(k_2) = p_2$.

Derivatives are approximated by centered differences, i.e.,

$$\frac{\partial S}{\partial y} \approx \frac{S_{j+1} - S_{j-1}}{2\Delta\phi}$$

and

$$\frac{\partial\overline{\theta}}{\partial p} \approx \frac{\overline{\theta}_{k+1} - \overline{\theta}_k}{p_{k+1} - p_k}$$

IV. Output

As an operational product, there are two forms of output of the energy calculations at each time. The first is a complete file at all standard levels from 100 to 5 KPA (1000 to 50 mb) maintained on a 36-day rotating disc file. The next section will discuss the access to the disc file and how to retrieve any desired information from it. At the end of each month, the daily data are collected, monthly means and standard deviations are calculated and the entire data set is archived on magnetic tape. In addition, hard copy of the energy output at 85, 50, 10, 5 KPA and total integral data are received by the Upper Air Branch, Development Division on a daily basis for monitoring purposes. A sample of the hard copy is shown in Figure 1 for 50 and 10 KPA and the total integral.

Looking first at the output at the 50 and 10 KPA, we see that the terms KZ,KE, C(AZ,AE), and C(KE,KZ) are printed at 5° latitude intervals from 80°N to 80°S along with latitudinal integrals of these terms from 20N to pole, 20N to 20S, and 20S to pole. In addition, the basic input parameters of the horizontal momentum flux [(u* v*)], horizontal sensible heat flux [(v* T*)], mean zonal wind ([u]) and mean zonal temperature ([T]) are also presented from 80N to 80S. The last column labeled WSZS is what we have termed BϕEP in Section II and is calculated only at 10 KPA. The results, as in the previous energy terms, are presented from 80N to 80S with integrated values over the three areas.

The total integral output is restricted to include only the six items of the energy equations described above and is presented for seven integrals: 100-10 KPA and 10-5 KPA (1000-100 mb and 100-5 mb) for the

Northern Hemisphere, Southern Hemisphere, and the globe. The last integral encompassing 20N to pole and 85-20 KPA was included to offer an extension to the multi-year series of calculations carried out by the NESS. A comparison of these calculations versus the previous ones computed from a different synoptic analysis set will be the subject of a future article.

Figure 1a

50 KPA PRESSURE LEVEL OUTPUT (SI UNITS) 0 G.M.T. 12 MAY 1975

LATITUDE	KZ J/KGM	KE J/KGM	C(AZ,AE) J/KGM/S	C(KE,KZ) J/KGM/S	(U*V*) M**2/S**2	(V*T*) M/S/K	(U) M/S	(T) K	(WSZS) J/M**2/S
80.0 N	309.44E-02	695.37E-01	55.83E-05	-90.43E-07	2.23	9.67	2.49	240.4	0.0
75.0 N	125.74E-01	732.12E-01	12.57E-04	-14.84E-06	-11.66	22.28	5.01	243.2	0.0
70.0 N	783.95E-02	104.20E+00	77.36E-05	-70.68E-06	-12.60	21.24	3.96	245.5	0.0
65.0 N	172.61E-02	129.66E+00	23.12E-05	-48.70E-06	-19.21	11.65	1.86	246.7	0.0
60.0 N	355.79E-02	150.34E+00	17.04E-05	13.58E-05	-33.54	6.50	2.67	247.5	0.0
55.0 N	238.64E-01	155.02E+00	20.79E-05	22.74E-05	-30.12	4.94	6.91	249.1	0.0
50.0 N	703.95E-01	103.41E+00	43.72E-05	63.97E-06	-12.73	8.26	11.87	251.1	0.0
45.0 N	101.22E+00	111.75E+00	55.86E-05	18.91E-06	14.88	8.56	14.23	253.5	0.0
40.0 N	852.23E-01	924.23E-01	85.60E-05	14.63E-05	25.12	11.34	13.06	256.4	0.0
35.0 N	538.12E-01	581.62E-01	48.24E-05	13.60E-05	24.61	7.07	10.37	259.7	0.0
30.0 N	368.08E-01	635.38E-01	61.95E-06	32.72E-06	11.20	1.22	8.58	262.4	0.0
25.0 N	290.22E-01	518.77E-01	89.87E-07	97.52E-07	3.34	0.23	7.62	264.4	0.0
20.0 N	149.21E-01	216.47E-01	28.81E-06	21.66E-06	3.67	0.94	5.46	266.1	0.0
15.0 N	146.35E-02	167.35E-01	23.99E-07	-80.72E-07	-1.16	0.14	1.71	267.3	0.0
10.0 N	130.35E-02	137.55E-01	-11.16E-07	-85.60E-07	-1.87	-0.18	-1.61	267.9	0.0
5.0 N	589.28E-02	953.09E-02	19.73E-08	13.59E-07	0.63	0.14	-3.43	268.0	0.0
0.0 N	862.96E-02	110.04E-01	33.14E-09	54.43E-08	0.66	0.14	-4.15	268.1	0.0
5.0 S	620.70E-02	119.35E-01	-51.39E-09	-23.54E-07	0.90	0.03	-3.52	268.0	0.0
10.0 S	742.46E-03	225.14E-01	41.20E-08	-26.89E-07	0.49	-0.06	-1.22	267.8	0.0
15.0 S	326.71E-02	215.33E-01	36.30E-07	40.90E-06	-4.96	-0.18	2.56	267.2	0.0
20.0 S	300.00E-01	284.10E-01	-30.63E-07	13.45E-05	-12.90	0.07	7.75	265.6	0.0
25.0 S	857.26E-01	471.74E-01	71.41E-06	14.03E-05	-15.44	-0.98	13.09	262.7	0.0
30.0 S	133.49E+00	597.97E-01	18.90E-05	75.55E-06	-15.95	-2.50	16.34	259.1	0.0
35.0 S	142.27E+00	467.11E-01	20.49E-05	48.12E-07	-4.99	-3.20	16.87	256.2	0.0
40.0 S	124.05E+00	702.25E-01	24.52E-05	38.42E-07	16.35	-3.72	15.75	253.7	0.0
45.0 S	109.41E+00	868.54E-01	59.62E-05	-27.11E-06	15.18	-9.13	14.79	251.2	0.0
50.0 S	111.56E+00	833.06E-01	35.11E-05	19.92E-07	-0.84	-8.11	14.94	249.0	0.0
55.0 S	866.69E-01	583.82E-01	-36.77E-06	-80.72E-06	-16.99	1.71	13.17	247.7	0.0
60.0 S	228.14E-01	483.70E-01	-41.91E-06	87.94E-06	7.93	2.94	6.75	247.0	0.0
65.0 S	543.33E-03	517.94E-01	10.74E-05	97.73E-06	25.66	-3.43	1.04	246.2	0.0
70.0 S	233.87E-02	540.78E-01	-92.30E-06	-16.28E-05	22.56	1.12	2.16	243.8	0.0
75.0 S	146.54E-01	393.39E-01	-55.47E-05	-54.92E-06	11.37	5.01	5.41	239.5	0.0
80.0 S	675.01E-02	466.44E-01	31.31E-06	-14.82E-06	-4.07	-0.74	3.67	236.1	0.0

INTEGRALS

	KZ	KE	C(AZ,AE)	C(KE,KZ)	(WSZS)
20 N TO POLE	417.74E-01	881.09E-01	36.97E-05	62.61E-06	0.0
20 N TO 20 S	572.75E-02	162.78E-01	19.70E-07	11.45E-06	0.0
20 S TO POLE	845.48E-01	582.32E-01	14.09E-05	28.30E-06	0.0

10 KPA PRESSURE LEVEL OUTPUT (SI UNITS)   0 G.M.T. 12 MAY 1975

LATITUDE	KZ J/KGM	KE J/KGM	C(AZ,AE) J/KGM/S	C(KE,KZ) J/KGM/S	(U*V*) M**2/S**2	(V*T*) M/S/K	(U) M/S	(T) K	(WSZS) J/M**2/S
80.0 N	245.71E-03	209.63E-01	20.65E-06	-79.55E-07	2.49	-0.95	0.70	228.3	0.0014
75.0 N	710.05E-03	214.92E-01	50.19E-06	-14.68E-06	-5.89	-3.98	1.19	226.5	0.0100
70.0 N	891.85E-04	242.06E-01	51.97E-06	-14.50E-06	-8.88	-4.01	-0.42	225.1	-0.0035
65.0 N	799.39E-05	262.23E-01	-21.79E-06	12.36E-06	-6.04	1.82	-0.13	223.7	0.0005
60.0 N	664.09E-03	258.49E-01	-50.49E-06	86.10E-07	-4.32	4.14	1.15	222.3	-0.0090
55.0 N	459.08E-02	244.14E-01	-64.24E-06	23.22E-06	-4.51	4.30	3.03	220.8	-0.0233
50.0 N	315.65E-01	259.65E-01	-41.40E-06	92.39E-07	-1.02	2.47	7.95	219.0	-0.0327
45.0 N	896.20E-01	445.26E-01	-23.89E-06	-43.92E-06	8.85	1.07	13.39	216.9	-0.0221
40.0 N	115.74E+00	586.76E-01	-16.18E-05	28.72E-06	15.21	4.92	15.21	214.0	-0.1049
35.0 N	995.82E-01	629.63E-01	-33.30E-05	23.04E-06	5.12	7.20	14.11	209.9	-0.1272
30.0 N	753.49E-01	781.56E-01	-33.59E-05	-67.79E-06	-14.53	6.31	12.28	204.8	-0.0845
25.0 N	500.77E-01	557.14E-01	-71.35E-06	-73.82E-06	-12.67	1.71	10.01	200.1	-0.0157
20.0 N	203.63E-01	310.16E-01	-28.90E-07	25.47E-07	0.31	0.12	6.38	197.2	-0.0006
15.0 N	129.80E-02	606.85E-01	-89.91E-07	41.13E-06	4.96	0.55	1.61	195.4	-0.0005
10.0 N	261.88E-02	729.14E-01	-39.33E-07	22.03E-06	3.85	0.42	-2.29	194.3	0.0004
5.0 N	131.80E-01	256.51E-01	37.44E-08	14.48E-06	3.00	-0.13	-5.13	193.8	-0.0001
0.0 N	275.85E-01	216.54E-01	26.74E-08	-34.29E-07	-1.00	-0.42	-7.43	193.7	0.0
5.0 S	180.39E-01	303.61E-01	-22.12E-07	24.08E-06	-3.19	-0.50	-6.01	193.8	0.0006
10.0 S	131.83E-03	492.74E-01	15.61E-07	53.99E-06	-3.96	0.21	0.51	194.4	0.0000
15.0 S	310.07E-01	272.99E-01	14.28E-06	10.70E-05	-8.89	1.06	7.87	195.2	0.0047
20.0 S	919.80E-01	367.71E-01	30.32E-06	14.37E-05	-14.22	0.91	13.56	197.1	0.0093
25.0 S	167.19E+00	511.54E-01	-12.77E-05	-56.68E-07	0.70	-2.30	18.29	201.4	-0.0387
30.0 S	206.45E+00	685.47E-01	-30.67E-05	94.09E-07	-7.65	-5.15	20.32	207.3	-0.1141
35.0 S	156.81E+00	739.79E-01	-14.78E-05	-68.60E-06	-12.77	-3.38	17.71	212.6	-0.0749
40.0 S	937.31E-01	797.76E-01	-10.46E-05	16.03E-06	6.46	-3.84	13.69	216.2	-0.0736
45.0 S	957.69E-01	112.94E+00	27.75E-06	-20.07E-06	2.90	1.48	13.84	218.6	0.0316
50.0 S	153.83E+00	125.18E+00	-20.86E-06	-66.71E-07	0.79	-4.12	17.54	220.0	-0.1207
55.0 S	163.15E+00	983.13E-01	65.57E-06	-28.10E-07	-8.26	-10.22	18.06	219.7	-0.3299
60.0 S	902.45E-01	572.00E-01	-39.40E-06	-99.55E-06	-13.92	-8.38	13.43	219.3	-0.2126
65.0 S	216.59E-01	643.98E-01	-48.30E-06	54.92E-06	4.34	-2.24	6.58	221.0	-0.0292
70.0 S	530.21E-02	834.75E-01	-28.85E-06	80.17E-05	37.39	-1.02	-3.26	223.9	0.0068
75.0 S	866.70E-01	101.62E+00	-50.88E-05	83.71E-05	45.52	-13.48	-13.17	227.4	0.3738
80.0 S	923.60E-01	116.66E+00	-10.03E-04	83.48E-06	31.35	-23.53	-13.59	232.0	0.6869
INTEGRALS									
20 N TO POLE	502.58E-01	444.09E-01	-11.12E-05	-13.71E-06					-0.0431
20 N TO 20 S	178.54E-01	400.76E-01	22.46E-07	42.71E-06					0.0013
20 S TO POLE	123.83E+00	798.34E-01	-12.17E-05	63.60E-06					-0.0501

Figure 1b

Figure 1c

TOTAL INTEGRAL OUTPUT

	NORTHERN HEMISPHERE		SOUTHERN HEMISPHERE		GLOBAL		20 N TO POLE
	100-10KPA	10-5KPA	100-10KPA	10-5KPA	100-10KPA	10-5KPA	85-20KPA
ZONAL AVAILABLE AZ J/M**2	309.17E+04	108.76E+03	385.11E+04	993.87E+02	345.70E+04	104.17E+03	186.75E+04
EDDY AVAILABLE AE J/M**2	502.40E+03	832.75E+01	490.89E+03	944.88E+01	495.55E+03	888.12E+01	477.75E+03
ZONAL KINETIC KZ J/M**2	366.12E+03	165.47E+02	723.83E+03	341.03E+02	544.98E+03	253.25E+02	374.33E+03
EDDY KINETIC KE J/M**2	613.08E+03	160.72E+02	492.89E+03	325.38E+02	552.99E+03	243.05E+02	656.67E+03
CONVERSION OF AVAILABLE C(AZ,AE) J/M**2/S	157.73E-02	-222.20E-04	674.26E-03	-230.90E-04	113.72E-02	-226.49E-04	204.65E-02
CONVERSION OF KINETIC C(KE,KZ) J/M**2/S	389.71E-03	-693.94E-06	479.82E-03	486.54E-04	434.77E-03	239.80E-04	501.08E-03

0 G.M.T. 12 MAY 1975

V. Disc Access

Access to the 36-day historical ENERGY files (HD36) is accomplished by the normal subroutines written to access the direct access binary data sets (i.e. the W3FK package). Information on labels of NMC data fields and the 36-day historical files are presented in Office Notes 84 and 108, respectively.

A listing to access (main) and print (subroutine ERGPRT) a complete file (all levels) for one time period of 1 day is presented below, in this case for June 1, 1975, 1200 GMT. We assume that the reader is familiar with the use of the W3FK routines and will concentrate here on the identification of the parameters in the subroutine ERGPRT as depicted on the set of dimension statements versus those defined in the text above. ƵK and EK correspond to the zonal and eddy kinetic energy, CA and CK are equivalent to what we have defined as C(AƵ,KƵ) and C(KE,KƵ) respectively. USVS and USTS refer to the horizontal momentum and sensible heat flux, [u* v*] and [v* T*], ƵU and ƵT are the mean zonal wind and temperature, [u] and [T], and WSƵS represents the BφEP term. All these fields are dimensioned (74, 12). The first index refers to the latitude: 1 is equator; 37 is north pole; 38 repeats equator; and 74 is south pole. The second index refers to the pressure level. The levels correspond to the mandatory levels, beginning with 100 KPA. The location of these fields within the two arrays TOTAL1 and TOTAL2 may be seen by examining the SUBROUTINE ERGPRT.

ƵKT, EKT, CAT, CKT and WSƵST represent the integrals of ƵK, EK, CA, CK and WSƵS over the three latitude regions, 20N to pole, 20N to 20S, and 20S to pole. These fields have the dimension (3, 12). The first index is for the region: 1 for 20N to pole, 2 for 20N to 20S, and 3 for 20S to pole. The second index is again for the pressure levels. The final hemispheric integrals are represented by TAZ, TAE, TZK, TCA, and TCK respectively. These are dimensioned (7). They are for the regions shown on the Total Integral Output:

1: Northern Hemisphere, 100-10 KPA

2: Northern hemisphere, 10-5 KPA

3: Southern hemisphere, 100-10 KPA

4: Southern hemisphere, 10-5 KPA

5: Global, 100-10 KPA

6: Global, 10-5 KPA

7: 20N to north pole, 85-20 KPA.

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//WWDDAJM  JOB (WD43008AC201000,WWB-A8),'DUBOFSKY',
//  REGION=256K,TIME=1,CLASS=B
//*
//* MAKE SURE THAT YOU USE THIS COPY PROC  AND DO NOT ACCESS THE
//*  ENERGY DATA SETS DIRECTLY
//  EXEC  NWSCOPYD,D='NWS.NMC.PROD.HD36.ENERGY2',T='&&ENRGY2',
//  NREC=288,CYL=10,P=1
//  EXEC  NWSCOPYD,D='NWS.NMC.PROD.HD36.ENERGY1',T='&&ENRGY1',
//  NREC=288,CYL=10,P=1
//* IF YOU USED THE ENERGY DATA SETS DIRECTLY AND
//* IF YOU GOOF YOU COULD WIPE OUT THE ENERGY CODE FOR A MONTH
//*
//  EXEC  NFORXCLG
//FORT.SYSIN  DD  *
      DIMENSION TOTAL1(3786),TOTAL2(4452)
      DIMENSION IDENT(5)
      DATA IDENT/Z0AC08000,0,0,0/
      DIMENSION  FLD(4452)
      REAL*8 ENRGY1,ENRGY2
       DATA ENRGY1/8HENRGY1  /,ENRGY2/8HENRGY2  /
      DIMENSION LOC1(289),LOC2(289),ID1(1737),ID2(1737)
C SET UP THE DATE
      IYR = 75
      MONTH =06
      IDAY = 01
      ICYCLE =12
      CALL W3FS11( IDATE,IYR,MONTH,IDAY,ICYCLE ,0     )
C OPEN THE HD36 ENRGY FILES
      CALL W3FK00(ENRGY2,LOC2,288)
      CALL W3FK00(ENRGY1,LOC1,288)
      CALL W3FK01(ENRGY1,ID1,288)
      CALL W3FK01(ENRGY2,ID2,288)
C CREATE THE FIFTH WORD OF THE ID
      CALL W3FS14(IDATE,254,IDENT(5))
C READ OFF THE DATA
      CALL W3FK03(ENRGY2,ID2,IDENT, FLD,288,4452,IERR)
      PRINT 1,IERR
C COPY THE DATA TO A DIFFERENT ARRAY
      DO 2 I=13,4452
      TOTAL2(I) =  FLD(I)
  2   CONTINUE
C CREATE THE FIFTH WORD OF THE ID
      CALL W3FS14(IDATE,255,IDENT(5))
C READ OFF THE DATA
      CALL W3FK03(ENRGY1,ID1,IDENT, FLD,288,3786,IERR)
      PRINT 1,IEPR
 1    FORMAT(' IERR IS ',I1)
C COPY THE DATA TO A DIFFERENT ARRAY
      DO 3 I=13,3786
      TOTAL1(I) =  FLD(I)
 3    CONTINUE
      CALL ERGPRT(TOTAL1,TOTAL2,MONTH,IDAY,IYR,ICYCLE)
      STOP
      END
      SUBROUTINE ERGPRT(TOTAL1,TOTAL2,MONTH,IDAY,NYR,ICYCLE)
      DIMENSION TOTAL1(3786)
      DIMENSION TOTAL2(4452)
      DIMENSION XMONTH (12)
      DATA XMONTH/' JAN',' FEB' ,' MAR' ,' APR',' MAY','JUNE','JULY',
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     A ' AUG','SEPT', ' OCT',' NOV', ' DEC'      /
      DIMENSION WHERE(3,3)
      DATA WHERE/ '20 N', ' TO ','POLE','20 N',' TO ','20 S','20 S',
     1' TO ','POLE'/
      DIMENSION IP(12)
      DATA IP/100,85,70,50,40,30,25,20,15,10     ,7,5/
      DO 50 K=1,12
      IX=IP(K)
      PRINT 55,IX,XMONTH(MONTH), IDAY,NYR,ICYCLE
   55 FORMAT(1H1,40X,I3,' KPA PRESSURE LEVEL OUTPUT (SI UNITS)',3X,
     1  A4,1X,I1X,I2,1X, ',19',I2,2X,I2,'Z',/2X,'LATITUDE',7X,'KZ',14X,
     A'KE',10X,
     2'C(AZ,AE)',7X,'C(KE,KZ)',10X,'(U*V*)',7X,'(V*T*)',7X,'(U)',
     37X,'(T)',5X,'(WSZS)'/15X,'J/KGM ',10X,'J/KGM ',
     48X,'J/KGM /S',7X,'J/KGM /S',8X,'KGM /S**2',7X,
     5'M/S/K',7X,'M/S',8X,'K',5X,'J/M**2/S'/)
      XIL=85.0
      DO 65 J=1,33,2
      J1=34-J
      XIL = XIL - 5.
      KX74  = 74*(K-1)+J1
      PRINT 90,XIL,TOTAL2(KX74+12),TOTAL2(KX74+900),TOTAL2(KX74+1788),
     1TOTAL2(KX74+2676),TOTAL2(KX74+3564),
     2TOTAL1(KX74+12),TOTAL1(KX74+900),TOTAL1(KX74+1788),TOTAL1(KX74
     3+2676)
   90 FORMAT(2X,F4.1,' N',4X,3PE11.2,4X,3PE12.2,4X,2PE11.2,4X,2PE11.2,
     14X,0PF12.2,F13.2,F11.2,F9.1,F11.4/)
   65 CONTINUE
      XIL=0.0
      DO 95 J=40,70,2
      XIL = XIL + 5.
      J1=J
      KX74  = 74*(K-1)+J1
      PRINT 91,XIL,TOTAL2(KX74+12),TOTAL2(KX74+900),TOTAL2(KX74+1788),
     1TOTAL2(KX74+2676),TOTAL2(KX74+3564),
     2TOTAL1(KX74+12),TOTAL1(KX74+900),TOTAL1(KX74+1788),TOTAL1(KX74
     3+2676)
   91 FORMAT(2X,F4.1,' S',4X,3PE11.2,4X,3PE12.2,4X,2PE11.2,4X,2PE11.2,
     14X,0PF12.2,F13.2,F11.2,F9.1,F11.4/)
   95 CONTINUE
  205 CONTINUE
      PRINT 101
  101 FORMAT(4X,'INTEGRALS'/)
      DO 105 I=1,3
      IXK = I * K
      PRINT 110,(WHERE(L,I),L=1,3),TOTAL1(3564+IXK),TOTAL1(IXK+3600),
     1TOTAL1(IXK+3636),TOTAL1(IXK+3672),TOTAL1(IXK+3708)
  110 FORMAT(2X,3A4,    3PE12.2,1X,3PE12.2,4X,2PE11.2,4X,2PE11.2,50X,
     10PF10.4/)
  105 CONTINUE
   50 CONTINUE
      PRINT 115
  115 FORMAT(1H1,60X,'TOTAL INTEGRAL OUTPUT'///34X,'NORTHERN  HEMISPHERE
     1'8X,'SOUTHERN  HEMISPHERE',15X,'GLOBAL',12X,'20 N TO P6LE'///33X,
     23('100-10KPA',6X,'10-5KPA',6X),1X,'85-20KPA'//)
      PRINT 116,(TOTAL1(J),J=3745,3751)
      PRINT 117,(TOTAL1(J),J=3752,3758)
      PRINT 118,(TOTAL1(J),J=3759,3765)
      PRINT 119,(TOTAL1(J),J=3766,3772)
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      PRINT 120,(TOTAL1(J),J=3773,3779)
      PRINT 121,(TOTAL1(J),J=3780,3786)
      PRINT 122,XMONTH(MCNTH),IDAY,NYR,ICYCLE
 123   FORMAT(1X,,1F2.0,' DAYS OF DATA WERE USED')
 116 FORMAT(4X,'ZONAL AVAILABLE',13X,7(3PE11.2,3X)/
    14X,'AZ  J/M**2'//)
 117 FORMAT(4X,'EDDY AVAILABLE',14X,7(3PE11.2,3X)/
    14X,'AE  J/M**2'//)
 118 FORMAT(4X,'ZONAL KINETIC',15X,7(3PE11.2,3X)/
    14X,'KZ  J/M**2'//)
 119 FORMAT(4X,'EDDY KINETIC',16X,7(3PE11.2,3X)/
    14X,'KE  J/M**2'//)
 120 FORMAT(4X,'CONVERSION OF AVAILABLE',5X,7(3PE11.2,3X)/
    14X,'C(AZ,AE)  J/M**2/S'//)
 121 FORMAT(4X,'CONVERSION OF KINETIC',7X,7(3PE11.2,3X)/
    14X,'C(KE,KZ)  J/M**2/S'//)
 122 FORMAT(///,50X      ,A4,2X,I2,'  ,19',I2,2X,I2,'Z')
      RETURN
      END
//LKED.SYSLIB  DD
//   DD
//   DD DSN=NWS.NMC.PROD.LOAD.W3LIB,DISP=SHR
//GO.ENRGY1  DD  DSN=&&ENRGY1,DISP=(OLD,PASS)
//GO.ENRGY2  DD  DSN=&&ENRGY2,DISP=(OLD,PASS)
//
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