ATMOSPHERIC ANGULAR MOMENTUM

EFFECTIVE ATMOSPHERIC ANGULAR MOMENTUM FUNCTIONS AND RELATED PARAMETERS COMPUTED AT THE U.S. NATIONAL METEOROLOGICAL CENTER

AAM(AER) 87 * 01

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I. Introduction

As described in the IERS Technical Note 2, twice daily analysis values of effective atmospheric angular momentum (EAAM) functions (Barnes et al., 1983) have been calculated from NMC global analyses throughout 1989. These include variables which relate to Earth rotation and polar motion. Starting 1 October 1989, the operational start date of the SBAAM, a more complete set of analysis and forecast values of EAAM functions and related analysis parameters have been produced.

II. SBAAM Data

Following Sub-Bureau specifications, two files have been produced by NMC beginning 1 October 1989. The first, an analysis file, contains hemispheric values of the EAAM functions χ_1, χ_2, and χ_3, each of which is further partitioned into wind, pressure, and pressure + inverted barometer components. The Sub-Bureau also requested that wind terms be calculated to 100 mb, as well as to the top of the model; however, this is done only for the χ_3 term. As a result of an earlier formulation, all NMC χ_3 values calculated before October 1989 were multiplied by a minus sign. This was stopped on 1 October. This file also contains analyses of zonal mean zonal wind, zonal mean temperatures, mean surface pressure and low order spectral coefficients of surface pressure. With the exception of the surface pressure fields, all analysis parameters and EAAM functions are derived from an initialized global analysis. The complete analysis file is produced twice daily, at 00 and 12 UTC. The second file contains 21 sets of forecast values (00-h to 240-h) of the EAAM functions at 12-hour intervals starting at 00 UTC. These values are globally integrated. A more complete description of both files is found in Table 1. Days with missing values from both files are listed in Table 2.

These data are archived monthly, and are also available from a dial-up service at NMC. The analysis file and forecast file are transferred once daily are maintained on a 10-day rotating file. An additional file is produced for the dial-up service only and contains hemispheric values of the EAAM functions and forecast values of zonal mean zonal winds. Complete information on the NMC files and dial-up system is found in a NMC User's Guide, available from the Sub-Bureau.

III. NMC Global Analysis and Forecast System

The NMC global data assimilation and forecast system is described in detail by Kanamitsu (1989). The global analyses are produced every 6 hours with an intermittent assimilation of data that uses a 6-h forecast as an initial guess. A diabatic nonlinear normal mode initialization procedure is performed on the analyses and is necessary for dynamic balance. The initialization procedure was changed on 14 December 1989 to a procedure which initializes only the analysis increments. This new procedure reduces the effect of the initialization on the analyses.

The NMC global forecast model has 18 vertical sigma layers and a horizontal resolution of 80 waves with triangular truncation. The EAAM functions are calculated after a vertical interpolation from the sigma coordinates to constant pressure levels (1000 mb to 50 mb) and a grid with horizontal resolution of 2.5 lat/lon. Therefore, wind integrals are calculated to 50 mb. Pressure terms are calculated on the model surface, where the orography is an enhancement of silhouette orography (Mesinger et al., 1988). On 14 December 1989 changes were implemented in the surface physics package which were designed to result in a more realistic cycle and pattern of evaportation. It is felt that this change will result in minor changes in the forecasted surface pressure.

Results of some of the NMC calculations are shown in the 1989 IERS Annual Report.

Table 1. CONTENT OF SBAAM FILES

Variable	Analysis File Specification	Array size
$\chi_2, \chi_2, \chi_2,$	hemispheric values of wind to 100mb, wind to top of model (50mb), pressure, pressure + inverted barometer	(8,3)
zonal mean zonal wind (m/s)	5 degree latitude bands, 12 mandatory pressure levels (1000 - 50mb)	(37,12)
zonal mean temperature (K)	5 degree latitude bands, 12 mandatory pressure levels (1000 - 50 mb)	(37,12)
mean global surface pressure (mb)		(1)
low-order spherical harmonics of surface pressure	4 wave, triangular truncation 20 wave, zonals only with and without inverted barometer	(30) (21) (30) (21)
	Forecast File	
$\chi_2, \chi_2, \chi_2,$	global values of wind to 100 mb, wind to top of model, pressure, pressure + inverted barometer; forecast lead times every 12 hours (00-h to 240-h)	21 arrays of (4,3)

Table 2. DAYS WITH MISSING DATA

	Analysis File (all parameters)	Analysis File (sfc coefficients only)	Forecast File
OCT 89	10/12 UTC 31/12 UTC	1/00 UTC 25/12 UTC - 26/00 UTC 27/12 UTC - 29/00 UTC	1, 2 (after 156-h), 28, and 29
NOV 89	-	-	-
DEC 89	-	-	14 and 21 (after 36-h)

REFERENCES

BARNES, R.T.H., R. HIDE, A.A. WHITE, and G.A. WILSON, 1983: Atmospheric angular momentum fluctuations, length-of-day changes and polar motion. *Proc. Roy. Soc. Lond.* **A, 387,** 31-73.

KANAMITSU, M., 1989: Description of the NMC Global Data Assimilation and Forecast System. *Wea. Forecasting,* **4**, 335-342.

MESINGER, F., Z.I. JANJIC, S. NICKOVIC, D. GAVRILOV and D.G. DEAVEN, 1988: The step-mountain coordinate: Model description and performance for cases of Alpine lee cyclogenesis and for a case of an Appalachian redevelopment. *Mon. Wea. Rev.*, **116**, 1493-1518.

AAM(AER) 87 * 01 Available from 1976 to 1990

Year	Number of meas.	Year	Number of meas.
1976	182	1984	679
1977	358	1985	686
1978	352	1986	696
1979	333	1987	722
1980	326	1988	679
1981	630	1989	711
1982	630	1990	720
1983	656		

EFFECTIVE ATMOSPHERIC ANGULAR MOMENTUM FUNCTIONS COMPUTED AT THE EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

AAM(ECMWF) 87 * 01

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As reported in the IERS Technical Note 2, effective atmospheric angular momentum (EAAM) functions have continued to be calculated at ECMWF throughout 1989. The EAAM functions are calculated for the analyses every 6 hours and for forecasts from 12 UTC each day to 10 days (see Sakellarides, 1989). The inverted barometer terms are not calculated. The data are archived at ECMWF but are not supplied to the Sub-Bureau.

In May of 1989, ECMWF implemented changes in the cumulus convection and radiation schemes of its global model. The effect, if any, of these changes on the EAAM series is not known.

References

Sakellarides, G., 1989: Atmospheric effective angular momentum fuctions for 1986-1987. *ECMWF Research Department Technical Report No. 62.*

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available from 1986 to 1991

Year	Number of Measurements
1986	365
1987	365
1988	732
1989	730
1990	730
1991	62

EFFECTIVE ATMOSPHERIC ANGULAR MOMENTUM FUNCTIONS COMPUTED FROM THE JAPAN METEOROLOGICAL AGENCY DATA AAM(JMA) 87 * 01

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The effective atmospheric angular momentum (EAAM) functions proposed by Barnes, Hide, White & Wilson (1983) have been computed from the global analysis data provided by the Japan Meteorological Agency (JMA) since September 28, 1983. In general, the operational numerical weather prediction produces the three data sets called the analysis-phase analysis data, the initialized phase analysis data and the predicted values. The JMA global analysis data are the analysis-phase analysis data. For the use of this file, it should be noticed that the results during 1983/12/1 - 1986/6/30 are once-a-day values computed from daily mean global data of the JMA global analysis data averaged at each grid and each level, otherwise twice-a-day(00 UT and 12 UT) values computed without averaging.

The JMA global analysis data have been made on 1.875-degree (2.5-degree before 1988/3/1) latitude-longitude grid system at sixteen levels (fifteen levels before 1988/3/1) up to ten millibars by the following analysis and forecast models. The analysis model is based on a multi-variate optimum interpolation method in troposhere and on a sinusoidal fitting method in stratosphere, with the initial guess of six hour forecast and the cut-off time of six hours after map time. The forecast model is based on a 1.875-degree (2.5-degree before 1988/3/1) and sixteen-level (twelve-level before 1988/3/1) global spectral model after a non-linear normal mode initialization with physics. The model has a horizontal resolution of triangular truncation at wavenumber 63 (42 before 1988/3/1) and incorpolates full physical processes. The details for the analysis and forecast models after 1988/3/1 can be found in Kitade(1988), and in Kashiwagi (1987) and Kanamitsu, Tada, Kudo, Sato & Isa (1983) for those before 1988/3/1.

For computing the EAAM functions, the sea level pressure, the geopotential height and the wind velocities at each level are used. In addition, mountain heights of the same grid system are used for estimating surface pressures on land and for computing sea lelvel pressures on ocean with the Inverted Barometer (IB) hypothesis. The surface pressures on mountains are computed from the geopotential heights by using a cubic spline interpolation technique with estimating the thickness temperatures by the same techniques. Vertical integrations of the wind terms of the EAAM functions are done from surface pressure on land (or the sea level pressure on ocean) to ten millibars. The integral formula to evaluate the EAAM functions are basically due to the equations (5.1), (5.2) and (5.3) of Barnes *et al* (1983), but the axial component of the EAAM functions is due to the equation (5.3) multiplied by -1 for convenience. No smoothing have been done after evaluation. Details of the evaluation can be found in Naito, Kikuchi and Yokoyama (1987).

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Barnes,R.T.H., R.Hide, A.A.White & C.A.Wilson, 1983 : Atmospheric angular momentum fluctuations, length-of-day changes and polar motion, *Proc. R. Soc. Lond.* **A 387**, 31-73.

Kanamitsu,M., K.Tada, T.Kudo, N.Sato & S.Isa, 1983 : Description of the JMA operational spectral model, *J. Meterol. Soc. Japan,* **61**, 812-828.

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Kitade,T.,1988 : Numerical weather prediction in the Japan Meteorological Agency, *JMA/NPD Technical Report,* **No.20.**

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AAM(JMA) 87 * 01
available from 1983 to 1990

Year	Number of Measurements
1983	150
1984	357
1985	365
1986	549
1987	730
1988	732
1989	730
1990	730

EFFECTIVE ATMOSPHERIC ANGULAR MOMENTUM FUNCTIONS CALCULATED AT THE U.K. METEOROLOGICAL OFFICE

AAM(UKMO) 83 * 01

Throughout 1989, 00-hour and forecast values of effective atmospheric angular momentum (EAAM) functions as described by Barnes et al. (1983) have been calculated twice daily, from 00 and 12 UTC. The functions are archived at 24 hour intervals to 6 days, the limit of the UKMO global model. The matter terms are calculated without applying the inverted barometer correction. The UKMO global model and data assimilation have been described in the IERS Technical Note 2; no significant changes were implemented in 1989. Changes are routinely documented in each "Quarterly report on numerical products from Bracknell."

The UKMO forecast file is sent to the Sub-Bureau every three months. Starting in mid-1990, twice daily transmissions of these data will be completed using the GTS data link.

References

Barnes, R.T.H., R. Hide, A.A. White, and C.A. Wilson, 1983: Atmospheric angular momentum fluctuations, length-of-day changes, and polar motion *Proc. R. Soc. Lon.* **A 387,** pp. 31-73.

Quarterly report on numerical products from Bracknell - U.K. Meteorological Office, London.

AAM(UKMO) 83 * 01 Available from 1983 to 1990

Year	Number of meas.	Year	Number of meas.
1983	241	1988	725
1984	366	1989	727
1985	365	1990	721
1986	306		
1987	721		