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Spectral Analyses, Climatology, and Interannual Variability of Nimbus-7 TOMS Version 6 Total Column Ozone

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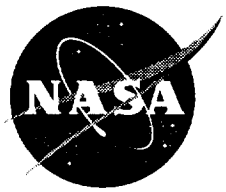

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ABSTRACT

This reference publication presents selected results from space-time spectral analyses of 13 years of version 6 daily global ozone fields from the Total Ozone Mapping Spectrometer (TOMS). One purpose is to illustrate more quantitatively the well-known richness of structure and variation in total ozone. A second purpose is to provide, for use by modelers and for comparison with other analysts' work, quantitative measures of zonal waves 1, 2, 3, and medium-scale waves 4-7 in total ozone. Their variations throughout the year and at a variety of latitudes are presented, from equatorial to polar regions. The 13-year averages are given, along with selected individual years which illustrate year-to-year variability.

The largest long wave amplitudes occur in the polar winters and early springs of each hemisphere, and are related to strong wave amplification during major warming events. In low latitudes total ozone wave amplitudes are an order of magnitude smaller than at high latitudes. However, TOMS fields contain a number of equatorial dynamical features, including Rossby-gravity and Kelvin waves.

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1. INTRODUCTION

Both the general Fast Fourier Transform (FFT) computing technique and the extensive Nimbus-7 TOMS (Total Ozone Mapping Spectrometer) instrument data are widely accessible, the latter on Compact Disk-Read Only Memory (CD-ROM). In the present reference publication, we illustrate the rich structure in TOMS data through the application of FFT space-time spectral analysis. To reduce space, we have given only selected detailed results aimed at illustrating major phenomena.

The results in this publication are intended to provide modelers with quantitative measures of the zonal means and asymmetries in total ozone for long waves 1, 2, and 3, and for medium-scale waves 4–7. Thirteen-year averages (climatologies) for 1979–1991 are given, along with monthly mean component fields to illustrate interannual variability. In addition, global space-time spectra covering latitudes 60° S to 60° N are provided for locating and identifying fastest waves. We also include an example of the use of this same space-time spectral method to find and describe a data processing artifact.

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2. NIMBUS-7 TOMS VERSION 6 DATA

The TOMS satellite provided daily global measurements of total column ozone from 31 October 1978 until 6 May 1993. Version 6 data (see *NASA Reference Publication RP-1323*, November, 1993) has been processed to include several improvements, among these being a long-term calibration correction for instrument degradation (beginning in April 1984) and a redefinition of B-pair wavelengths used in the retrieval scheme. The data used in this technical note come from daily asynoptic fields on CD-ROM derived by the Goddard Ozone Processing Team (OPT) at NASA's Goddard Space Flight Center (GSFC) in Greenbelt, Maryland. Coverage on CD-ROM extends from 1 November 1978 through 31 January 1992 (total of 4840 days) and is conveniently gridded into 1° latitude by 1.25° longitude bins.

2.1. Gridding Process and Missing Data

Because the relatively long horizontal scales investigated in this report did not require the full TOMS data set, the CD-ROM data were compacted by regridding onto a 5° × 5° latitude-longitude field, extending from latitudes 85° S to 85° N. Zonally averaged monthly mean percentages of missing 5° × 5° data were found to be less than about 2–3% at all latitudes (excluding polar night) and all months from June 1980 to January 1992. The worst month is June 1979 for which ~30%-40% of data is missing at latitudes not in polar night. (No TOMS measurements were available for 14–19 June 1979 because of a

relay malfunction.) Similarly, July 1979 through May 1980 have roughly 5%–10% missing data. All missing data in this report were replaced using linear interpolation in time.

2.2. Potential Data Problems

2.2.1. Clouds

A primary improvement in version 6 TOMS over previous versions was correction of the instrument degradation problem (*Herman et al.*, 1991), but there still exist other problems that could be improved in future versions. One problem relates to an assumed climatological cloud top height (a function only of latitude) in the retrieval process. It was shown by *Thompson et al.* (1993) that low marine stratus clouds, occurring lower in altitude than the climatological cloud heights used in the algorithms, induce a small positive bias in TOMS version 6 values; largest daily and monthly mean biases west of Africa around 5–25° S during August-October months were found in that study to be ~+20 and +5 Dobson Units (DU), respectively. This result underscores the care needed if using TOMS version 6 data in such regions to estimate tropospheric ozone. Other oceanic regions in which low marine stratus clouds are a common occurrence is west of South America and west of North America.

Another potential problem with version 6 TOMS relates to Polar Stratospheric Clouds (PSCs) and episodic (life spans ~2–5 days) "miniholes" that appear in the high latitudes of both hemispheres around winter months. As discussed by *Rood et al.* (1992), wintertime miniholes can be generated dynamically by the uplifting of ozone-poor tropospheric air during the passage of an anticyclone. This uplifting of air contributes to colder than normal lower stratospheric temperatures, and can result in formation of PSCs. In these much more rare cases involving PSCs, it is not uncommon for TOMS measurements inside miniholes to be significantly smaller than ground based measurements. One event in February 1990 indicated TOMS measurements inside a Northern Hemisphere minihole to be around 100 DU less than estimated ground-based measurements. (*Hofmann and Deshler,* 1990; *Fiedler et al.,* 1993).

2.2.2. Gridding Artifact Revealed by Spectral Analysis

As one illustration of the usefulness and sensitivity of space-time analysis of TOMS, we briefly describe a data processing artifact found in the analyses. Figure 1*a* shows eastward/westward spectral amplitudes for zonal wave 14 covering years 1979–1991. Seen in this figure is a peculiar spectral feature with period near 6 days. While there is a known westward propagating wave 1 atmospheric global normal mode with period around 5 days, the feature seen here is not related to it. Reasons for this assertion are first, that the spectral peak in Figure 1*a* is exceptionally sharp, having a period that is always very close to 5.7 days, throughout the entire 13-year TOMS; this is too sharp for a wave mode in the real atmosphere. Second, the main contribution was found to occur at wave 14, suspiciously close to the number of orbits per day, with respect to the Earth grid, made by the Sun-synchronous Nimbus-7 satellite. This feature is an artifact caused by cross-track bias. The effect is strongest in low latitudes where orbital scans do not overlap.

Moreover, largest amplitudes in Figure 1 are directly related to aerosol loading of the stratosphere, being strongest after two major volcanic eruptions that occurred during the TOMS record, the Mexican El Chichon in early 1982 and Mt. Pinatubo in the Philippines in mid-1991. These artifacts are strongest at 20° N after El Chichon and at 10° S after Pinatubo (Figures 1*a* and 1*b*, respectively). In years of more normal aerosol loading in the stratosphere, errors are seen to be much reduced in magnitude. In conclusion, original gridding used in version 6 CD-ROM TOMS results in ~1–5 DU errors in low latitudes. Space-time spectral analysis thus provides a sensitive tool for detection of data processing artifacts.

3. THIRTEEN-YEAR CLIMATOLOGY

Thirteen-year climatologies of TOMS ozone are shown in Figure 2. Because of polar night, latitudes poleward of 65° are not included. (TOMS data requires backscattered sunlight for its measurements.) The time mean and RMS amplitudes in the left half of Figure 2 can be compared with the earlier version TOMS 4-year (October 1978–September 1982) calculations of *Bowman and Krueger* (1985). The most significant differences between the results in Figure 2 and those of *Bowman and Krueger* are the slightly larger amplitudes in version 6 TOMS for the time mean field. Time mean values in Figure 2 are ~5–20 DU larger (largest biases in high latitudes) than values shown in Figure 3 of *Bowman and Krueger*.

The two right-half frames in Figure 2 show RMS amplitudes for planetary scale waves 1–3 and medium-scale waves 4–7. Prior to computing RMS amplitudes in time for these latter two cases, an inverse FFT was used to select only waves 1–3 or waves 4–7, respectively. Waves 1–3 are seen to be strongest in high latitudes, primarily because of planetary scale fluctuations of total ozone during stratospheric sudden warmings in Northern Hemisphere winter and the winter vortex breakup in spring in both hemispheres. Medium-scale waves 4–7 are strongest in total ozone in middle latitudes because of forcing from strong midlatitude medium-scale baroclinic instabilities. This can be seen from the continuity equation for ozone volume mixing ratio X:

$$X_t = -uX_x - vX_y - wX_z + S. \tag{1}$$

Here subscripts denote partial differentiation, S represents ozone sources or sinks, and u, v and w are the eastward, northward and vertical velocity components, respectively. All other symbols are standard. Atmospheric wind velocity (u, v, w) therefore induces waves in the ozone mixing ratio field X subject to the gradients of X. Wave perturbations (denoted by prime symbol) in total column ozone measured by TOMS are given by

$$\Omega' = 0.772 \times 10^5 \cdot \int_0^\infty dz \cdot \rho \cdot X' \approx 10^5 \cdot \int_0^\infty dz \cdot e^{-z/H} \cdot X', \tag{2}$$

where units are DU, z is altitude (units meters), X' represents perturbations in mixing ratio, H is scale height (7 km here), and ρ (units kg·m^{-3}) is the total atmospheric mass density approximated by $1.3 \cdot e^{-z/H}$. Strong baroclinic waves in the upper troposphere and lower stratosphere can thus induce sizeable waves in total ozone.

Tabulated values of the fields in Figure 2 are provided in Table 1 on the following page. Included in this table (and several following tables) are values at the equator. TOMS values corresponding to latitudes in polar night are flagged with the value 999 in all tables provided in this technical report.

Figure 3 shows climatological monthly mean TOMS ozone, averaged using November 1978 through January 1992 fields. Tabulated data (Table 2) are included in the immediate following pages.

4. MONTHLY MEAN FIELDS AND INTERANNUAL VARIABILITY

Shown in Figure 4 are monthly mean polar stereographic TOMS ozone fields for years 1978-1992 in both hemispheres for seasonal months January, April, July, and October. Also shown for completeness are climatology fields (denoted "CL") for each month, computed by averaging TOMS over the years shown on each page.

Monthly mean TOMS ozone data for zonal waves 0-7 are also given in this report, shown in Table 3 in the following pages. With time coverage November 1978 through January 1992, these tables provide a detailed account of interannual and interseasonal variability in monthly mean wave components. Amplitudes (units DU) are given in these tables for zonal wavenumbers 0, 1, 2, 3, and combined medium-scale waves 4–7. Zonal phases (units degrees) are included for waves 1, 2, and 3. The expression needed to reconstruct a specific wave component (fixed zonal wavenumber k) monthly series from these tables is given by

$$\Omega(x = 0, 1, ..., 71; t = 1, 2, ..., 159) = AMP(k,t) \cdot \cos\left[\frac{2\pi k x}{72} - \Phi(k,t)\right] \qquad (3)$$

where t is now a month index, beginning with November 1978, and $AMP(k,t)$ and $\Phi(k,t)$ are the tabulated amplitudes and phases. Longitude (in units degrees) is given by $-180 + 5x$.

5. VARIABILITY ON SHORTER TIME SCALES

To illustrate temporal variability at time scales shorter than, say a month, no temporal filtering was applied to the data used in any of the figures shown in this section. The only filtering employed was along longitude (using an FFT) to select fields for zonal wave 0 (zonal mean), 1, 2, 3, and 4–7.

Figure 5 shows selected (1979, 1980, 1991, and climatology) latitude vs. time plots of TOMS total ozone for waves 0, 1, 2, 3, and 4–7. Values shown for waves 1, 2, and 3 are RMS amplitudes. Values involving waves 4–7 are also RMS amplitudes, but were computed from $[\sum_{k=4}^{k=7} AMP^2(k,t)]^{1/2}$. All of the 13-year climatological fields shown in Figure 5 were calculated by averaging equivalent days of similar months. (Example: the 1 January values were calculated by averaging 1 January 1979, 1 January 1980, ..., 1 January 1991.)

Pre-ozone hole years 1979 and 1980 are given, together with 1991, a deep ozone hole year. The 13-year mean is also given. In considering the 13-year mean, both here and in

the figures to follow, it is worth remembering that the ozone hole was especially deepening from the mid-1980s onwards. Thus, in Antarctic latitudes the 13-year means will show more ozone than the latter years and less than the first few years of the 13-year record.

Figure 5 reveals more variability, and more ozone, in the Northern Hemisphere (NH) winters than in Southern Hemisphere (SH) winters. The ozone hole is perspicuous during October in high Southern latitudes. A quasi-biennial oscillation in ozone hole strength (*Lait et al.*, 1989) is apparent in the yearly analyses (not all shown here). In addition, even at non-Antarctic latitudes, there is significant year-to-year variability. Nevertheless, the 13-year means are useful to give some indication of recurring features. A prominent example of this is the major buildup of total ozone in high latitudes in late winter/early spring that is caused by residual mass transport from summer to winter hemispheres. Related to this mean residual circulation are large wave activities discussed next..

Figure 5 (c)–(j) demonstrates wave activity in total ozone as a function of latitude and time. Planetary wave activity during stratospheric warmings and spring final breakdowns of the polar night vortex are especially prominent during winter/early spring, in both the NH and SH. Strong amplitude vacillations are revealed in waves 1 and 2 in total ozone, primarily during late winter and early spring when the winter polar vortex (both NH and SH) is disturbed by large wave amplification events during sudden stratospheric warmings and final spring warmings, respectively.

Amplitudes of wave 3 and medium-scale waves 4–7 are seen to have relatively sizeable amplitudes on the majority of days in winter/spring in both hemispheres. The medium-scale ozone perturbations (waves 4–7) are primarily induced by strong baroclinic disturbances in the upper troposphere; the latter are dynamically forced by large-scale temperature gradients rather continuously throughout the winter and spring. This can be compared with the strong amplitude long waves in ozone that are manifestations in total ozone of midwinter and final spring warming events. The wave amplitudes can be read from the plots with values for individual years typically exceeding 100, 60, 50, and 25 DU for waves 1, 2, 3, and 4–7, respectively. During October and early November 1991, especially large amplitudes are seen in the pronounced contortions of the spring breakup of the Antarctic polar vortex. That year's Southern ozone hole was the deepest observed in zonal means, and its morphology was exceptionally elongated (nonzonal) at times (*Krueger et al.*, 1992).

In the 13-year mean, waves 1 and 2 are seen to be more pronounced in the Antarctic spring (starting in the last half of September) and in the NH high latitudes in the last part of January through most of March; medium-scale waves 4–7 are more uniformly distributed throughout both winter and spring in both hemispheres.

Figure 6 shows time vs. longitude plots of TOMS ozone at selected latitudes for years 1979, 1985, and 1991. In high Southern latitudes, pronounced amplitudes and eastward phase propagation of wave 2 is evident around the time of the ozone hole and breakup of the stratospheric polar vortex. The perturbations in total ozone at middle and high latitudes can be understood on the basis of the approximate conservation of potential vorticity (*Vaughan and Price*, 1991). Stationary wave behavior is a characteristic in the tropics and subtropics for longest waves 1–2. *Shiotani* (1992) suggested that the dominant stationary wave 1 in total ozone along the equator could be due to smaller total column

ozone associated with a higher tropopause from strong tropical convection in the western Pacific. Note that lowest total ozone along the equator for wave 1 occurs near the dateline for each of the three years shown here in Figure 6. A portion of this stationary wave 1 in TOMS has been shown to be a retrieval artifact, related to the presence of persistent low marine stratus clouds (see section 2.2.1). In addition, there is evidence that there may also be a contribution from tropospheric ozone originating from biomass burning. For example, *Shiotani and Hasebe* (1994) analyzed Stratospheric Aerosol and Gas Experiment (SAGE) data by integrating ozone mixing ratio from 16 to 60 km, forming a "stratospheric only" ozone column. Their results with SAGE data indicated an absence along the equator of a dominant wave 1 in stratospheric only column ozone (zonal wave 2 was instead dominant). This suggests that the observed wave 1 in TOMS may have contributions from tropospheric ozone.

The equatorial wave 4–7 analyses at times indicate possible coherent pulses of medium-scale wave activity: see, for example, August-October 1985 in Figure 6 (1985, EQU). Careful examination of tropical TOMS data has resulted in the identification of both Rossby-gravity waves (*Stanford and Ziemke*, 1993) and Kelvin waves (*Ziemke and Stanford*, 1994a) in total ozone. (Kelvin waves in ozone mixing ratio were previously shown by *Hirota et al.*, 1991, and *Randel*, 1991.) In addition, *Ziemke and Stanford* (1994b) show and describe the synchronization between these fast tropical waves in total ozone and the quasi-biennial oscillation of the equatorial zonal wind.

Figure 7 shows space-time spectra for January 1979 through December 1991 at latitudes 60° S to 60° N (15° increment). Each 1979–1991 frame shows spectra at a fixed latitude for a distinct zonal wavenumber, or combination of wavenumbers in cases involving waves 4–7. These plots are best described as monthly series of TOMS westward/eastward spectral amplitudes at fixed latitude and zonal wavenumber(s). These monthly spectra were computed using a 90-day window stepped forward in time with a 1-month increment. During each 90-day calculation, time series averages were removed and a 10%–10% cosine taper window was applied to reduce leakage. (Ten percent, or 9 days, of each end of every 90-day series was tapered smoothly to zero with a half-cosine bell.) These spectra calculations used an exact method to separate space-time series into eastward and westward components (see, for example, the Appendix of *Ziemke and Stanford*, 1990). Harmonic coefficients $A(k,p)$ and $B(k,p)$ for the 90-day running window were calculated by applying an FFT in both time and space under the following zonal space-time harmonic expansion for total column ozone Ω:

$$\Omega_{\pm}(x=0,1,...,71;t=0,1,...,89) = \sum_{k=0}^{36}\sum_{p=0}^{45}\Big[A_{\pm}(k,p)\cdot\cos(\kappa x \pm \omega t) + B_{\pm}(k,p)\cdot\sin(\kappa x \pm \omega t)\Big]. \quad (4)$$

Here, t (x) is the day (longitude) index, $\kappa = 2\pi kx/72, \omega = 2\pi pt/90$, and $+$ ($-$) denotes the westward (eastward) propagating component of Ω. Longitude (in units degrees) is given by $-180 + 5x$.

Spectral amplitude in Figure 7, whether computed for a single zonal wavenumber ($k_1 = k_2$) or for combined wavenumbers ($k_2 > k_1$), was derived from $< \sum_{k=k_1}^{k=k_2}[A^2(k,p) +$

$B^2(k,p)]^{1/2}>$, where the angle brackets denote one application of a 0.25–0.5–0.25 smoothing along frequency index p.

The spectra in Figure 7 are potentially useful for identifying fast wave events in total ozone for selected zonal wavenumber(s). Examples include high-latitude planetary waves 1–3 during winter and spring, and baroclinic disturbances (seen in waves 4–7) in midlatitudes. By using Figure 7, important characteristics of such disturbances can be identified, including time of the occurrence, approximate latitude domain, oscillation period, effective amplitude (over the 90-day window used), and direction of zonal propagation. Interhemispheric comparison of high-latitude waves can also be deduced. For example, large amplitude waves occur during polar vortex breakup in late winter in both polar regions. In the North, the activity is primarily in winter (November through March), which often includes major midwinter stratospheric warming events. Activity is relatively weak in other seasons at 60° N. At 60° S, in addition to the obvious strong wave developments during vortex breakdown in the Antarctic spring, note the considerable activity of waves 1 and 2 during the Antarctic autumn, April-May and at times lasting into early winter, June. This bimodal distribution of autumn and spring longwave activity in total ozone may be related to the double maximum in wave 1 amplitude found in geopotential analyses by *Randel* (1988).

6. ON THE DYNAMICAL FORCING OF TOTAL OZONE WAVES

Insight into the dynamical forcing of TOMS zonal waves 1–7 examined in this reference publication is provided in Figure 8, which shows seasonal correlations between TOMS ozone and British Meteorological Office (BMO) geopotential heights for planetary scale waves 1–3 and medium-scale waves 4–7. These calculations used 12 years (1 January 1980 through 31 December 1991) of daily BMO geopotential heights. These datasets (with the same horizontal gridding as 5° × 5° TOMS) extend from the low troposphere up to the stratopause on the following eleven pressure surfaces: 850, 500, 300, 200, 100, 50, 20, 10, 5, 2, and 1 hPa. Up to 100 hPa the BMO data are NMC analyses; Stratospheric Sounding Unit (SSU) radiance temperatures are used to obtain stratospheric geopotential heights. It should be noted that this same correlation procedure was applied using the full NMC data extending from 1 to 850 hPa for 1980–1991. No observable differences were found between results in Figure 8 and correlation fields derived from the full NMC data.

The seasonal correlation plots in Figure 8 were computed from daily measurements of 3D (latitude, longitude, pressure) BMO and 2D (latitude, longitude) TOMS data by first computing their cross-field correlations for each month of each particular year. In this first step (following zonal wavenumber truncation in these data for either waves 1–3 or 4–7 via a Fast Fourier Transform), at each fixed latitude and longitude, the monthly series of TOMS was cross-correlated with that of geopotential heights at each of the eleven vertical pressure levels (850 to 1 hPa); this resulted in 144 monthly (January 1980–December 1991) 3D (latitude, longitude, pressure) correlation fields. The next step was to average these 3D correlation fields over equivalent months. (For example, the January correlation field was derived by averaging fields for January 1980, January 1981, ..., January 1991.) The final step was to average these 3D correlation fields zonally, resulting in the 2D (latitude, pressure) fields shown in Figure 8. Monte Carlo statistical significance tests for various

significance levels are noted in the figure caption. Because of the large amount of BMO and TOMS data involved, the Monte Carlo method used a simplified approach incorporating a red-noise model each month for both random time series $x(t)$ used in the cross-correlation calculations: $x(t) = a \cdot x(t-1) + Z(t)$, where $Z(t)$ is a randomly generated standard normal series and the constant parameter a was set equal to 0.99 as a reasonable upper bound for the redness of monthly sequences of both TOMS ozone and BMO heights. Correlations were calculated monthly and then averaged over 12 similar months, just as was done with the TOMS and BMO data. (This process was repeated 100,000 times to establish the significance level values stated in the Figure 8 caption.)

Results in Figure 8 show that both planetary and medium-scale waves in TOMS ozone are highly anticorrelated with lower atmospheric geopotential heights around 200-300 hPa at latitudes 35° -60° in both hemispheres. The strong anticorrelations are indicative of the "tropopause effect" in total ozone whereby a higher than average tropopause altitude, in principal, yields a smaller than average amount of vertically integrated total column ozone above. This effect can also be understood on the basis of potential vorticity conservation.

Figure 8 also shows that these strong negative correlations tend to follow seasonal migration of the tropospheric eastward wind jet that maximizes (in both hemispheres) near 200 hPa around latitudes 30° in winter and 45° in summer. This latter observation suggests that horizontal advection of ozone associated with the tropospheric jet is a primary source for observed midlatitude zonal waves 1–7 in TOMS ozone in all seasons. This appears most evident for medium-scale waves 4–7.

In addition, planetary waves 1–3 in TOMS ozone show strong positive correlations with midstratospheric geopotential heights at high latitudes in Figure 8. This effect dominates during Southern springtime (October shown) when large stratospheric waves 1–3 in temperature occur in association with the zonal variations and ultimate breakup of the polar stratospheric wind jet. Large midstratospheric geopotential height perturbations are indicative of perturbed lower stratospheric thicknesses (i.e., temperatures).

In summary, medium-scale waves 4–7 in TOMS, particularly in midlatitudes, appear to be forced by a combination of tropopause effects related to height changes and horizontal advection associated with the eastward tropospheric wind jet. As noted earlier, medium-scale waves are primarily caused by baroclinic instability processes. Planetary waves 1–3 appear similarly affected by the tropospheric jet, but less so. Largest correspondence between TOMS ozone and lower stratospheric thicknesses at planetary scales occur in the high latitudes during Southern springtime in association with the breakdown of the Southern polar vortex.

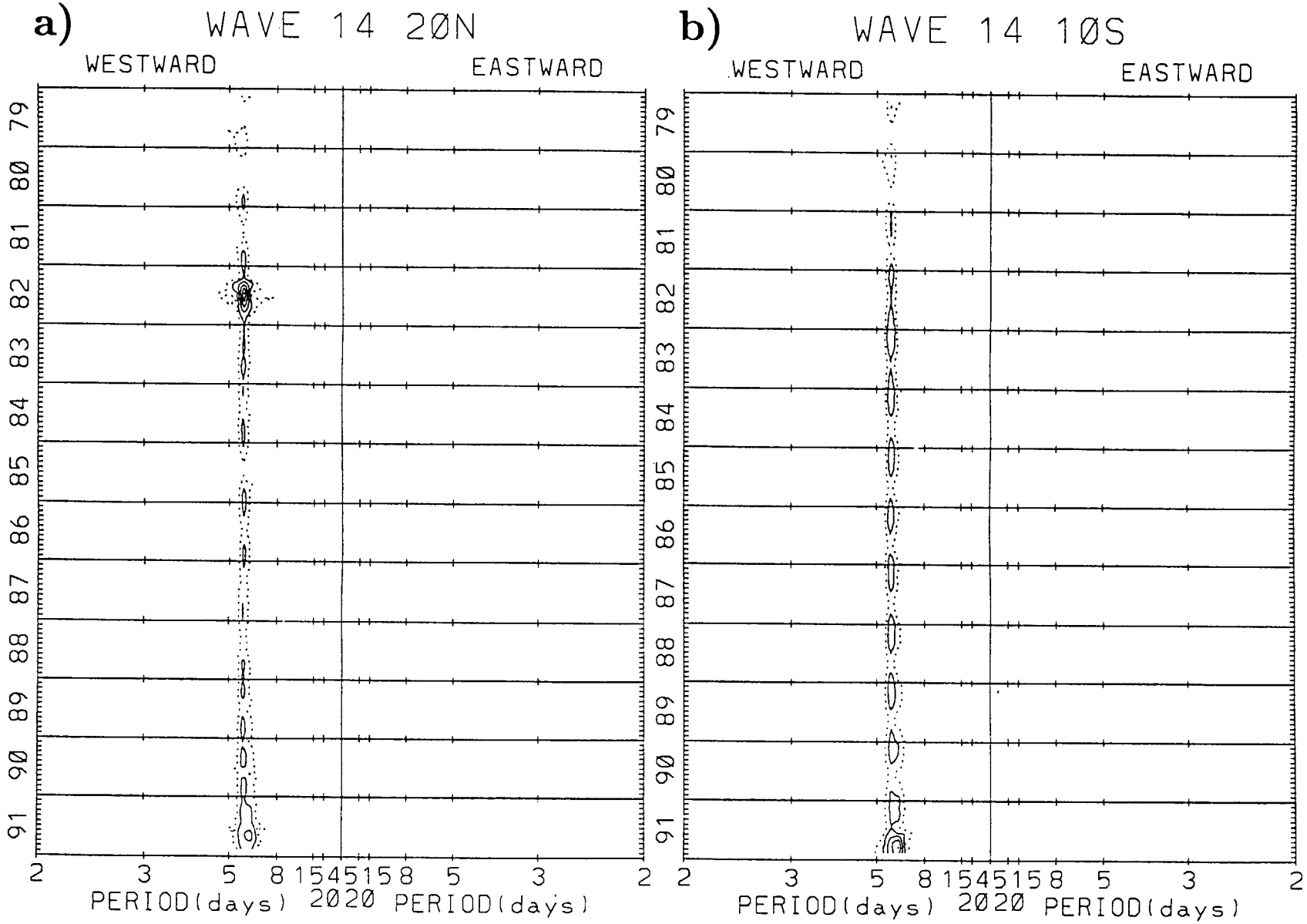


Figure 1. Time vs. frequency (periods in days shown) TOMS eastward/westward spectral amplitudes for zonal wave 14 computed using a 90-day window with a one month step. Days: 1 January 1979–31 December 1991. Units: DU. Dashed (solid) contours 0.5 (1, 2, 3,...). (a) Latitude 20°N. (b) 10°S.

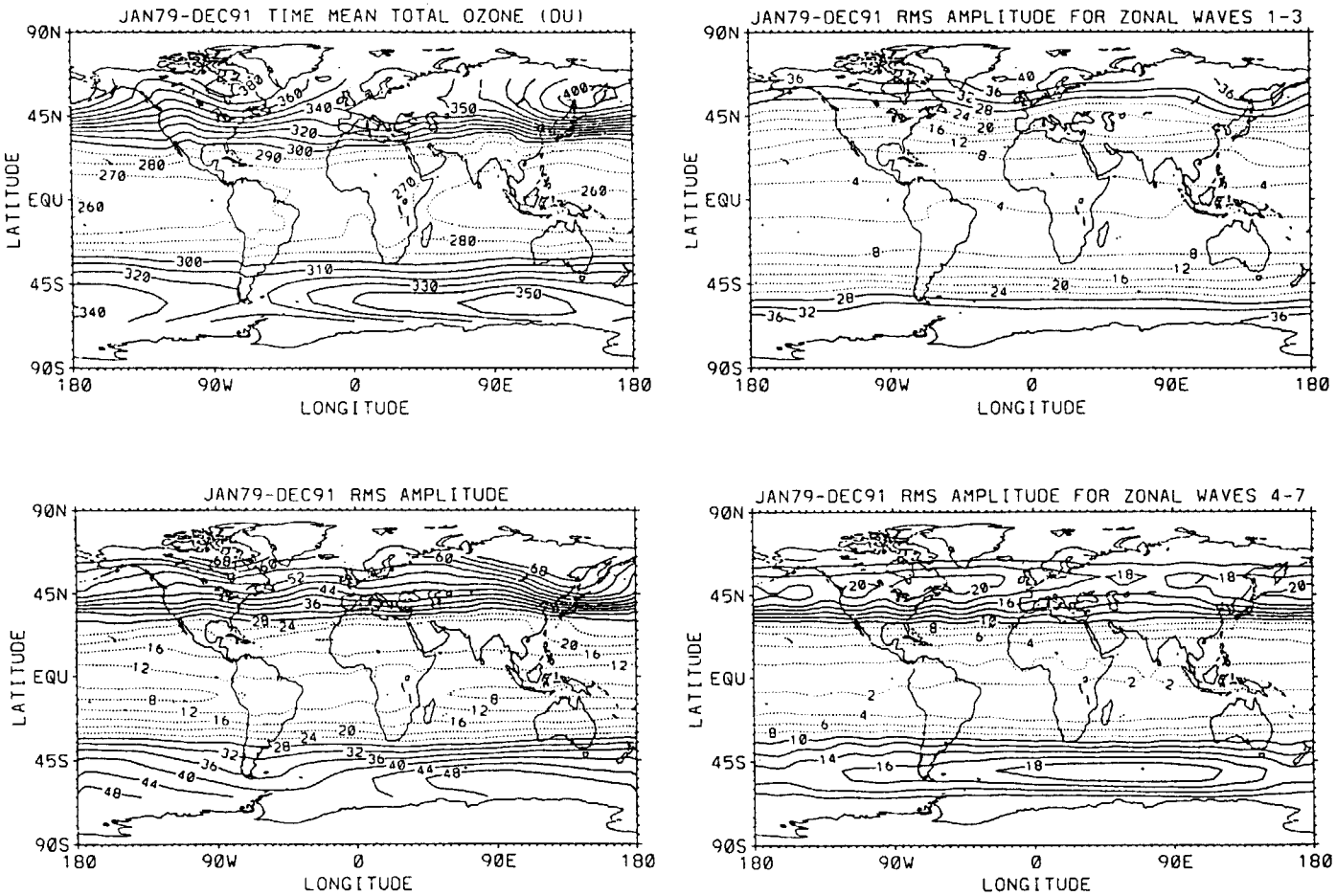


Figure 2. TOMS total ozone time mean and RMS amplitudes computed using daily data from 1 January 1979 through 31 December 1991. All units: DU. Upper Left: Time mean. Dashed (solid) contours begin at 290 (300) and decrement (increment) by 10. Lower left: RMS amplitudes for all zonal wavenumbers. Dashed (solid) contours begin at 24 (28) and decrement (increment) by 4. Upper right: RMS amplitudes for zonal waves 1–3. Dashed (solid) contours begin at 24 (28) and decrement (increment) by 4. Lower right: RMS amplitudes for zonal waves 4–7. Dashed (solid) contours begin at 8 (10) and decrement (increment) by 2. Tabulated values are provided on the following page.

Table 1. Climatological TOMS: Thirteen-year Averages

CLIMATOLOGY: JAN79-DEC91

LONGITUDE

	-180	-160	-140	-120	-100	-80	-60	-40	-20	0	20	40	60	80	100	120	140	160
JAN79-DEC91 TIME MEAN TOTAL OZONE (DU):																		
65N	395.7	386.1	371.4	372.8	382.3	386.2	377.4	365.5	355.5	348.6	343.1	344.2	347.8	359.2	369.3	381.8	390.5	395.2
60N	398.7	386.9	370.8	362.1	373.8	385.7	377.3	366.4	353.9	347.4	344.9	345.6	348.0	358.9	371.3	386.9	399.3	401.4
55N	397.1	384.4	369.0	351.7	362.3	379.6	373.3	361.9	348.4	345.3	347.3	348.7	350.4	359.6	370.8	389.9	407.2	402.6
50N	387.1	374.0	358.8	343.9	350.9	364.8	364.0	351.1	340.8	343.7	347.0	349.2	349.7	355.0	362.0	387.3	400.0	396.3
45N	365.7	355.3	343.3	333.1	337.3	351.1	350.0	336.9	333.5	338.3	344.8	342.6	341.2	337.8	347.0	373.0	383.5	376.5
40N	336.8	332.9	326.9	320.7	324.5	333.1	330.8	323.7	327.8	330.0	337.8	329.3	325.5	317.2	324.4	349.5	351.7	342.7
35N	310.1	313.8	313.8	315.2	312.0	315.0	312.7	314.2	321.4	318.4	324.7	314.2	306.1	294.7	295.6	319.8	314.3	308.3
30N	294.4	300.5	303.2	306.5	299.6	299.3	299.8	305.7	310.7	302.6	304.0	294.2	289.8	283.1	277.4	294.2	288.1	287.4
25N	286.2	290.9	292.6	293.7	285.3	286.8	291.0	296.3	296.7	289.0	285.8	281.1	282.0	279.6	271.8	280.2	275.9	278.7
20N	279.3	281.2	281.4	282.2	274.4	279.5	282.5	285.6	283.9	278.5	275.6	276.2	277.1	272.8	269.1	271.3	270.3	273.8
15N	271.5	272.1	272.3	272.8	272.1	273.9	275.3	277.3	277.3	275.0	273.5	273.2	274.2	269.9	268.0	266.8	266.8	269.1
10N	264.7	265.5	266.7	267.8	269.2	270.0	269.9	272.4	275.4	277.0	273.4	267.9	272.5	268.6	266.5	264.8	263.6	263.7
5N	260.7	261.5	263.1	264.8	267.0	267.7	265.4	270.0	274.2	278.3	273.3	270.5	269.7	267.0	263.5	262.1	260.3	259.9
EQU	259.5	261.1	262.5	263.9	264.9	266.9	265.2	270.5	274.3	277.3	273.7	271.2	267.0	264.4	261.4	258.9	257.6	258.2
5S	259.3	261.2	263.0	263.7	264.2	264.3	266.9	270.8	274.8	278.2	273.4	271.3	265.7	263.1	262.1	259.3	255.1	258.1
10S	260.0	261.4	263.9	265.2	265.7	267.7	267.8	271.9	275.5	280.6	270.6	272.1	267.3	264.4	264.4	263.9	261.5	259.5
15S	264.2	265.1	267.3	269.4	270.1	273.3	269.0	273.5	276.7	281.7	271.4	275.5	272.3	269.5	269.6	268.9	267.7	265.7
20S	272.7	273.0	274.0	276.2	277.1	278.1	274.1	276.7	278.9	281.8	274.3	280.6	278.1	276.4	276.1	273.5	274.2	274.6
25S	284.2	284.2	283.3	284.0	284.9	284.5	281.8	283.3	284.3	285.2	278.3	284.9	283.5	284.2	284.3	279.9	283.0	285.5
30S	298.6	298.5	295.5	293.3	293.7	293.9	290.7	292.9	293.3	292.9	287.9	291.4	291.6	293.9	296.4	293.1	295.2	298.7
35S	313.0	313.0	309.6	304.5	303.1	304.1	300.5	303.4	304.4	303.8	301.3	300.4	301.7	305.2	310.0	309.3	309.2	312.4
40S	322.9	323.4	320.7	315.3	313.2	312.6	309.7	313.2	315.9	316.7	315.2	312.9	313.6	317.9	323.9	323.9	321.8	322.9
45S	329.9	329.9	327.4	323.2	320.5	318.7	316.1	321.4	326.5	329.6	329.8	327.6	327.9	332.4	338.3	337.3	332.3	330.6
50S	335.3	334.1	332.0	328.0	324.8	321.8	318.9	326.1	333.6	339.0	341.3	340.4	341.0	346.0	351.2	349.6	341.9	337.1
55S	339.2	337.2	334.7	330.0	325.6	321.2	318.3	324.7	332.8	340.5	345.8	346.8	348.8	354.2	358.8	357.2	348.9	342.4
60S	341.7	338.5	333.9	327.6	321.5	316.1	312.4	315.7	321.4	331.2	338.3	340.1	343.7	349.8	354.2	354.7	350.7	345.6
65S	338.6	334.3	327.8	319.4	312.2	306.0	301.4	301.2	304.7	310.0	317.1	321.5	326.1	331.1	336.4	339.9	341.5	340.7
JAN79-DEC91 RMS AMPLITUDE (ALL ZONAL WAVES):																		
65N	64.1	62.4	61.4	64.0	70.1	71.2	66.5	61.5	60.2	59.6	59.4	59.8	62.1	68.8	73.9	74.7	74.3	69.8
60N	57.7	56.5	54.5	55.0	61.8	65.2	59.8	57.0	56.6	57.2	56.5	55.1	55.8	60.7	66.9	70.3	71.4	66.0
55N	54.8	53.1	51.7	50.0	53.9	58.9	55.2	53.7	52.1	54.4	53.3	50.8	51.5	54.1	58.8	66.3	70.7	64.2
50N	53.6	51.5	50.6	48.0	49.2	51.4	52.0	49.3	46.5	49.8	49.0	47.2	48.1	47.8	50.9	61.0	66.2	61.8
45N	51.2	47.9	46.0	45.0	43.7	46.9	47.9	43.6	41.3	44.8	44.2	42.7	42.5	41.1	42.9	53.1	60.0	58.7
40N	42.8	40.5	39.5	40.6	37.2	40.2	41.3	37.7	37.2	38.4	39.2	39.2	36.2	32.7	34.5	42.3	49.1	48.9
35N	31.6	32.8	33.4	33.5	29.6	32.4	33.4	32.4	32.4	30.2	31.6	30.2	28.2	25.8	26.0	30.5	33.5	34.0
30N	27.6	28.5	28.0	26.9	22.8	26.6	27.3	26.8	25.4	21.5	22.5	21.0	19.3	19.6	18.8	21.9	24.6	27.0
25N	26.1	25.2	22.9	21.3	19.9	22.7	22.5	20.9	18.5	16.7	17.5	17.2	16.9	17.2	18.2	20.5	23.7	25.9
20N	22.3	20.5	18.3	17.9	18.7	20.1	19.2	17.0	15.9	17.0	17.2	17.2	17.7	17.7	18.7	19.6	22.0	23.1
15N	17.6	16.4	15.6	16.1	17.3	18.5	17.5	16.4	16.8	17.0	16.8	16.4	16.9	16.2	16.9	18.1	18.7	18.8
10N	13.3	13.3	13.8	14.8	15.7	16.0	15.8	15.2	14.9	14.9	14.2	14.5	14.8	14.1	14.4	15.5	14.9	14.3
5N	11.4	11.5	12.0	12.7	13.6	13.6	13.4	12.7	12.7	12.5	11.1	13.0	12.3	12.2	12.4	12.4	11.9	11.4
EQU	10.3	10.7	10.8	11.3	12.1	12.9	12.4	12.1	11.6	11.2	10.6	11.0	10.8	10.7	10.9	10.4	10.0	9.9
5S	8.1	8.5	8.4	8.7	9.2	9.5	10.9	10.0	9.3	9.8	9.1	9.4	8.5	8.3	8.4	8.3	8.0	7.7
10S	6.6	6.8	6.8	6.6	7.0	9.1	9.3	9.2	8.6	10.6	7.9	9.1	7.9	7.0	7.1	7.4	7.4	6.9
15S	9.6	9.3	9.4	8.9	8.6	10.0	9.8	11.2	10.9	12.7	10.1	11.4	10.5	9.6	9.6	9.8	10.3	10.2
20S	13.9	13.7	13.4	12.8	12.4	12.3	12.0	13.4	13.0	13.9	12.2	13.8	13.6	13.0	13.0	12.8	13.1	14.0
25S	17.8	18.1	17.6	16.6	16.9	16.6	15.4	15.9	16.2	16.2	14.4	15.8	16.3	16.0	16.5	16.3	16.3	17.4
30S	23.4	24.1	23.5	22.1	21.7	22.2	20.1	20.5	21.0	20.4	18.6	19.2	20.3	20.2	21.3	22.2	22.1	23.2
35S	31.0	30.9	30.6	28.8	27.5	27.4	25.6	26.2	26.7	26.3	24.9	24.7	26.1	26.3	28.0	29.4	30.0	30.6
40S	36.9	36.7	36.0	33.7	32.1	31.0	30.0	30.8	31.8	31.9	31.6	31.9	33.2	33.8	35.4	36.2	36.3	36.6
45S	40.3	40.9	39.1	36.9	35.2	32.9	32.4	34.4	35.9	36.5	37.2	38.1	39.9	41.2	41.9	41.6	40.8	40.3
50S	42.4	43.1	41.3	39.2	37.4	34.8	34.3	36.7	39.2	40.4	42.2	43.9	46.1	47.5	47.5	46.5	44.6	43.5
55S	44.6	45.1	43.7	41.7	39.8	37.5	36.1	37.8	40.1	42.5	45.3	47.4	50.1	50.6	50.6	49.8	48.3	46.7
60S	47.2	47.4	45.8	43.8	42.2	40.4	38.9	39.5	40.9	42.6	45.2	46.8	48.5	49.7	50.7	51.0	50.5	49.9
65S	48.6	49.2	48.1	46.5	45.3	43.9	43.3	42.3	42.5	42.6	43.7	44.9	45.9	47.5	49.1	50.2	50.5	50.9
JAN79-DEC91 RMS AMPLITUDE (ZONAL WAVES 1-3):																		
65N	37.1	36.6	35.3	35.3	36.9	37.2	36.2	37.2	39.6	40.0	38.5	37.7	37.4	36.1	35.0	36.1	37.4	37.4
60N	33.8	32.3	31.3	31.9	34.2	34.3	33.0	35.0	38.2	38.0	35.4	33.9	33.8	32.8	32.4	35.4	38.2	36.9
55N	30.6	28.6	28.4	28.4	29.7	29.7	28.8	31.4	34.6	33.7	30.0	28.0	28.1	27.6	28.4	33.5	37.6	35.6
50N	27.2	25.3	25.7	24.6	24.4	25.2	25.6	27.8	30.2	28.6	24.3	22.1	22.5	22.8	24.6	29.9	34.0	32.3
45N	23.7	21.2	21.8	21.3	20.3	20.6	21.4	23.8	26.0	23.9	19.3	18.1	19.5	20.5	22.0	25.2	28.2	27.8
40N	19.3	17.1	17.8	17.9	16.6	15.9	17.5	20.6	21.6	18.4	15.4	17.1	19.1	19.3	18.9	19.5	21.4	21.9
35N	14.5	14.3	13.9	13.6	13.0	13.2	14.9	16.2	15.3	13.2	13.6	16.3	17.8	17.3	15.6	14.1	13.6	14.1
30N	13.1	12.3	10.5	9.3	9.4	10.7	11.4	10.7	10.0	10.7	11.9	12.4	12.0	11.6	11.0	9.7	9.6	11.7
25N	11.3	9.9	8.3	7.3	7.4	8.0	7.7	7.8	8.9	9.4	8.9	7.9	7.0	7.2	7.6	7.3	8.6	10.9
20N	8.9	7.7	6.9	6.4	6.3	6.2	6.2	6.9	7.4	7.0	6.6	6.1	5.5	5.7	6.0	6.2	7.8	9.2
15N	6.4	5.9	5.5	5.2	5.2	5.1	5.1	5.4	5.5	5.2	4.9	4.6	4.4	4.7	4.9	5.4	6.5	6.9
10N	4.4	4.3	4.1	4.0	4.1	4.1	4.0	3.9	3.9	3.7	3.6	3.5	3.8	4.0	4.2	4.5	4.8	4.6
5N	3.1	3.1	3.1	3.2	3.3	3.4	3.5	3.5	3.5	3.1	3.0	3.4	3.8	3.8	3.8	3.8	3.6	3.3
EQU	3.0	3.1	3.1	3.0	3.1	3.5	3.9	4.0	3.8	3.2	3.0	3.5	3.8	3.8	3.9	3.8	3.4	3.0
5S	3.4	3.3	3.3	3.3	3.2	3.5	4.2	4.5	4.2	3.6	3.6	3.8	3.8	3.8	4.1	4.1	3.7	3.4
10S	4.0	4.1	4.1	3.8	3.6	3.7	4.1	4.6	4.8	4.5	4.3	4.3	4.1	4.0	4.2	4.3	4.2	4.1
15S	4.9	5.1	5.3	5.0	4.6	4.4	4.3	4.9	5.7	5.6	5.0	4.8	4.8	4.6	4.6	4.8	5.0	5.1
20S	5.9	5.9	6.1	6.3	6.2	6.0	5.6	5.4	5.9	6.0	5.5	5.1	5.0	5.1	5.4	5.6	5.7	5.9
25S	6.3	6.4	6.3	6.6	7.1	7.4	7.1	6.7	6.4	6.2	6.2	6.2	6.0	6.0	6.3	6.5	6.4	6.2
30S	8.5	8.7	8.3	7.9	8.3	8.9	8.9	8.4	7.8	7.5	7.6	7.9	8.1	8.3	8.2	8.3	8.5	8.4
35S	12.3	12.4	12.1	11.6	11.2	11.2	11.5	11.3	10.6	10.3	10.4	10.6	10.7	10.8	10.6	10.9	11.5	12.0
40S	15.9	16.0	16.0	15.2	15.8	15.1	14.7	14.9	14.8	14.3	13.9	13.6	13.4	13.4	13.3	13.3	14.0	15.1
45S	19.8	20.1	20.2	21.2	21.9	20.9	19.6	19.4	19.6	19.3	18.5	17.5	17.5	18.0	17.8	17.2	17.3	18.5
50S	24.6	24.9	24.7	26.0	27.5	26.8	25.0	24.3	24.5	24.7	24.2	23.5	23.7	24.3	23.7	22.5	22.0	23.1
55S	29.3	29.4	29.1	30.2	31.8	31.8	30.7	29.8	29.3	29.4	29.7	29.6	29.7	29.9	29.2	27.9	27.2	28.0
60S	34.7	34.0	32.4	32.6	34.2	35.2	35.3	35.0	34.0	33.3	33.4	33.5	33.3	33.1	33.1	32.9	33.0	33.9
65S	39.4	37.3	34.3	33.2	33.9	34.7	35.0	35.1	34.7	34.3	34.2	34.0	33.8	34.1	34.5	35.0	36.6	38.8
JAN79-DEC91 RMS AMPLITUDE (ZONAL WAVES 4-7):																		
65N	13.9	14.0	14.0	13.9	14.6	14.7	15.3	15.5	15.6	15.1	15.3	14.4	14.9	14.4	14.8	14.7	14.5	14.5
60N	16.1	16.4	16.3	16.7	16.8	17.5	18.0	18.2	18.3	17.9	17.3	16.8	17.0	16.5	17.2	16.3	16.8	16.1
55N	18.3	18.1	18.4	18.6	18.9	19.9	20.2	20.3	20.1	19.4	18.6	18.0	18.4	17.9	18.6	17.8	18.3	17.8
50N	20.2	19.7	19.7	20.1	20.1	21.1	20.5	20.7	19.9	18.8	18.2	17.5	18.0	17.4	18.3	18.5	19.4	19.4
45N	21.2	20.5	19.8	20.4	19.1	20.8	18.9	19.4	18.1	17.3	16.3	16.1	15.9	16.2	16.7	18.4	19.5	20.3
40N	19.0	18.5	17.6	18.3	16.6	18.7	16.5	16.9	15.9	15.3	14.7	14.4	13.6	14.2	14.2	16.5	17.5	18.5
35N	13.9	14.0	13.5	14.3	13.2	14.7	13.0	13.6	13.2	12.8	13.0	12.1	12.0	11.5	11.7	12.8	13.3	14.3
30N	8.6	9.1	9.2	9.8	9.4	9.9	9.4	9.6	10.0	9.8	10.2	9.6	9.6	8.5	8.3	8.0	7.9	8.5
25N	5.9	6.2	6.5	6.5	6.7	6.4	6.8	6.4	6.6	6.6	6.2	6.0	5.7	5.5	4.9	5.2	4.9	5.5
20N	4.5	4.5	4.8	4.6	4.7	4.3	4.7	4.6	4.2	4.3	3.6	3.6	3.3	3.5	3.5	3.5	3.7	3.9
15N	3.3	3.5	3.5	3.3	3.2	3.0	3.1	3.1	2.7	2.7	2.4	2.4	2.5	2.5	2.7	2.8	2.9	3.1
10N	2.3	2.3	2.3	2.1	2.1	2.0	2.1	2.1	2.0	2.0	2.1	2.0	2.2	2.3	2.2	2.3	2.2	2.4
5N	1.6	1.6	1.7	1.6	1.7	1.8	1.8	1.9	1.8	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.8	1.7
EQU	1.5	1.4	1.4	1.5	1.6	1.8	1.8	1.9	1.8	1.9	1.8	2.0	1.9	1.9	1.8	1.6	1.7	1.4
5S	1.7	1.7	1.6	1.7	1.8	2.0	2.1	2.1	2.1	2.0	2.0	2.1	2.1	2.1	2.0	1.8	1.8	1.7
10S	2.3	2.3	2.0	2.2	2.1	2.2	2.4	2.4	2.3	2.5	2.3	2.6	2.5	2.5	2.5	2.3	2.3	2.3
15S	3.1	3.1	2.8	2.9	2.6	2.8	2.7	2.7	2.6	2.8	2.6	2.9	2.9	2.9	3.0	3.0	3.0	3.2
20S	4.0	4.4	4.1	4.0	3.9	3.8	3.7	3.6	3.3	3.2	3.1	3.2	3.3	3.4	3.6	3.7	3.8	4.3
25S	6.0	6.2	6.0	6.1	6.1	5.5	5.8	5.2	5.1	4.6	4.4	4.4	4.3	4.8	4.8	5.2	5.6	5.9
30S	8.5	8.8	8.5	9.3	8.8	8.8	8.6	8.2	7.8	7.4	7.1	7.0	7.0	7.4	7.3	8.0	8.0	8.1
35S	10.2	10.6	10.8	12.1	11.5	12.1	11.5	11.3	11.2	10.7	10.5	10.2	10.3	10.5	10.4	10.6	10.3	9.6
40S	11.8	11.7	12.6	13.8	13.4	14.2	14.0	14.0	14.4	14.0	14.2	13.9	14.0	14.1	13.8	13.3	12.6	11.3
45S	13.6	13.3	14.3	15.2	15.2	15.5	15.9	16.2	16.9	17.2	17.5	17.5	17.6	17.5	17.0	16.3	15.0	13.4
50S	14.7	14.4	15.7	16.2	16.5	16.5	17.0	17.4	18.2	18.8	19.4	19.7	19.9	19.8	19.2	18.1	16.7	14.8
55S	14.6	14.4	15.7	16.0	16.5	16.1	16.4	16.4	17.0	17.7	18.2	18.4	18.9	18.8	18.6	17.6	16.6	14.8
60S	13.1	13.0	14.2	14.4	14.8	14.2	14.1	13.8	14.0	14.4	14.7	15.0	15.2	15.4	15.6	15.1	14.7	13.2
65S	10.4	11.2	11.6	11.7	11.9	11.6	11.3	11.0	10.8	10.9	10.8	11.0	11.0	11.4	11.5	11.6	11.2	11.2

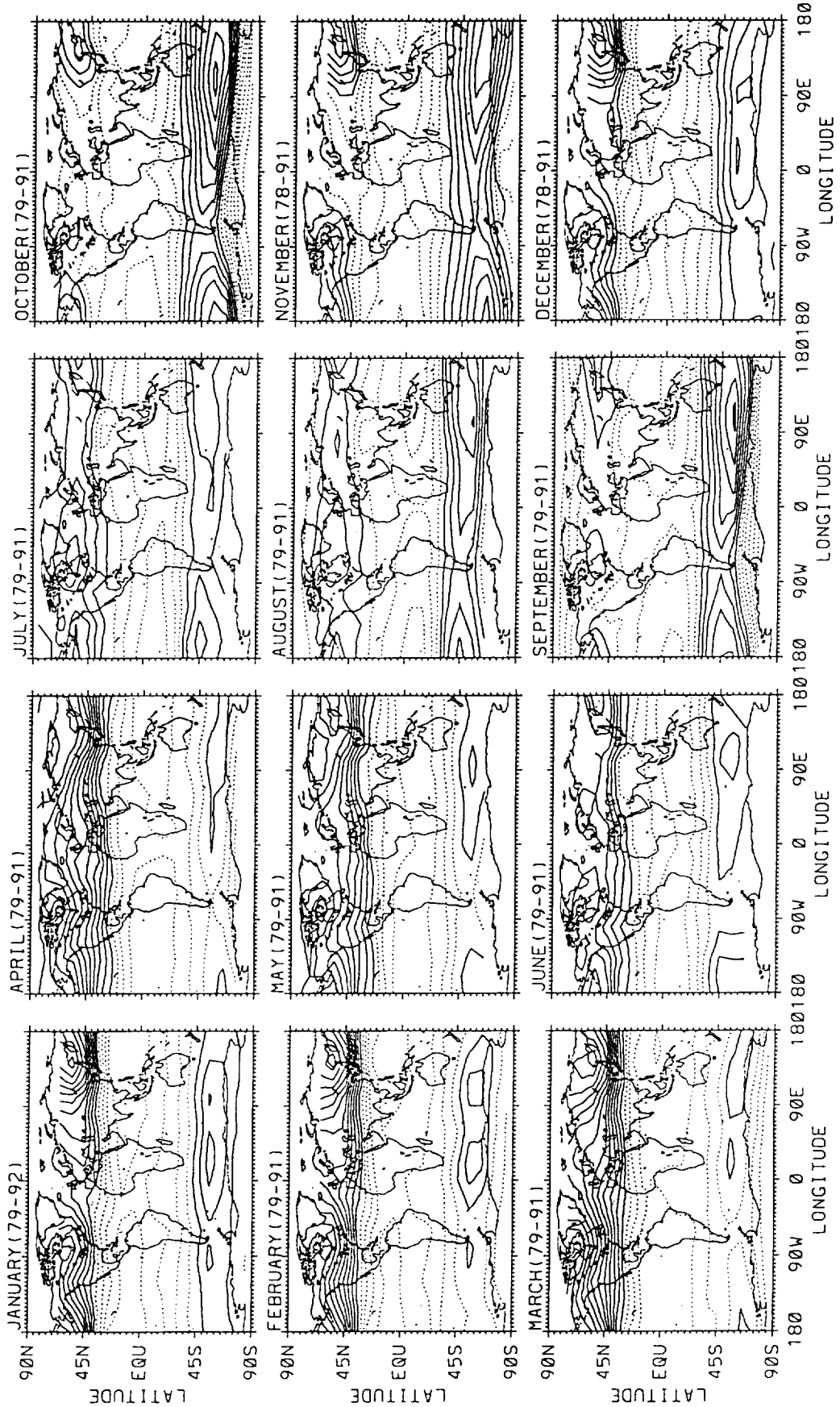


Figure 3. Climatological monthly mean TOMS ozone (units DU) computed using November 1978 through January 1992 monthly fields. Dashed (solid) contour values begin at 300 (315) and decrement (increment) by 15. Tabulated values are included in following pages.

Table 2. Climatological TOMS: Monthly Averages

MONTHLY CLIMATOLOGY: LATITUDE VS LONGITUDE

LONGITUDE

	-180	-160	-140	-120	-100	-80	-60	-40	-20	0	20	40	60	80	100	120	140	160
JANUARY(79-92):																		
85N	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
75N	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
65N	445	430	411	408	411	402	378	356	344	335	335	342	352	369	395	428	454	453
55N	435	409	378	364	386	402	386	356	330	330	339	351	365	375	397	443	471	459
45N	398	373	344	329	352	369	354	328	318	330	347	357	367	362	374	411	429	417
35N	306	308	300	303	308	307	294	297	306	315	325	326	321	306	310	327	319	307
25N	253	262	271	276	268	263	263	276	283	275	271	267	265	262	259	259	246	246
15N	246	250	254	254	251	250	251	257	255	252	249	248	250	247	244	241	240	242
5N	246	248	250	250	251	249	249	254	259	262	257	253	253	251	248	246	245	245
EQU	249	251	253	253	253	253	253	260	263	267	262	257	255	253	251	248	249	249
5S	254	255	258	258	257	257	259	267	269	271	265	260	258	255	256	255	253	254
15S	262	264	267	271	269	267	264	275	279	280	271	269	267	265	267	266	265	264
25S	276	278	277	279	277	274	271	279	279	281	277	279	277	278	276	272	274	278
35S	293	296	294	291	291	289	287	294	293	293	292	291	290	292	294	292	290	293
45S	305	307	307	307	312	311	307	314	319	323	323	318	314	316	320	317	312	309
55S	320	321	323	327	332	331	326	333	341	347	351	349	345	344	346	342	332	324
65S	321	320	321	322	327	326	327	325	329	334	338	340	339	340	337	331	331	324
75S	316	313	311	308	311	312	313	312	314	313	313	314	318	317	317	320	320	321
85S	305	305	303	301	299	301	302	302	303	303	304	303	303	304	305	307	307	307
FEBRUARY(79-91):																		
85N	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
75N	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
65N	462	450	436	439	448	451	430	407	390	374	373	379	389	413	437	459	475	477
55N	447	425	405	396	418	437	428	406	375	366	379	386	391	408	429	464	489	475
45N	414	388	367	357	373	390	387	366	347	358	376	385	388	388	397	430	453	440
35N	329	325	317	316	321	318	312	311	321	340	340	340	336	323	322	340	338	328
25N	265	273	279	282	275	270	274	289	293	284	278	274	275	271	269	270	257	257
15N	251	254	256	256	254	253	256	261	259	255	254	253	255	253	251	246	245	247
5N	249	250	251	252	252	252	251	256	260	264	259	256	257	255	251	248	247	247
EQU	252	253	254	255	254	255	255	260	264	268	263	260	258	256	254	251	251	251
5S	255	256	258	258	257	258	260	266	269	271	266	263	260	258	258	256	254	255
15S	258	262	265	268	267	265	263	273	277	277	268	267	264	263	265	264	261	259
25S	268	270	271	274	272	271	269	274	275	277	274	274	272	272	270	266	269	271
35S	288	288	286	285	283	283	283	284	284	287	286	284	284	288	287	284	283	287
45S	294	294	297	300	302	300	298	298	303	313	311	302	299	305	310	307	300	296
55S	302	300	305	312	316	317	312	313	321	333	338	332	324	327	333	334	325	312
65S	313	307	306	308	311	312	310	309	313	325	333	331	329	329	331	332	329	322
75S	308	300	290	286	287	287	287	289	294	296	299	300	304	304	303	309	312	313
85S	288	286	282	278	275	276	277	278	281	282	283	283	283	285	287	290	291	291
MARCH(79-91):																		
85N	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
75N	477	475	479	484	488	485	468	438	431	422	416	418	430	449	464	473	478	476
65N	464	454	441	454	476	484	466	439	424	410	406	407	413	435	461	479	484	472
55N	451	432	413	403	423	443	431	409	389	391	399	403	412	423	444	475	494	476
45N	416	393	383	375	381	393	391	367	354	368	383	391	393	390	400	433	451	441
35N	330	332	339	341	336	336	334	328	333	340	355	349	339	322	328	347	345	337
25N	285	297	302	296	284	284	290	301	303	295	290	286	284	283	282	283	273	276
15N	266	270	267	265	264	264	269	273	272	268	265	264	266	265	263	258	258	260
5N	255	256	256	257	258	260	258	262	267	271	268	266	266	263	259	257	255	254
EQU	256	257	257	259	260	261	260	264	268	273	269	268	267	263	260	257	256	256
5S	257	258	259	260	261	262	263	268	271	274	269	267	265	263	261	259	256	257
15S	258	261	262	264	265	264	261	271	275	277	269	268	266	264	264	264	260	260
25S	267	268	268	269	270	269	266	271	273	275	273	274	273	272	271	268	268	271
35S	283	284	284	282	281	281	279	282	281	280	282	281	281	284	286	283	282	285
45S	284	285	288	292	292	291	292	297	297	300	301	295	291	293	300	298	291	286
55S	299	297	299	300	301	299	298	304	309	315	319	317	313	316	321	322	316	307
65S	318	316	313	310	305	301	297	298	301	305	309	308	311	315	319	323	325	324
75S	314	309	301	293	290	284	282	282	282	278	280	284	291	292	295	299	305	312
85S	270	269	267	264	261	259	257	258	256	256	257	257	258	260	263	267	269	271
APRIL(79-91):																		
85N	448	447	446	446	448	446	444	442	442	443	445	449	453	456	456	455	453	450
75N	457	454	452	453	461	461	452	431	432	427	430	440	455	465	470	468	467	462
65N	456	441	422	429	446	457	445	426	413	409	414	419	429	448	460	464	462	458
55N	442	432	419	396	404	426	417	400	390	400	404	399	397	406	429	450	460	449
45N	398	393	388	374	376	394	395	374	377	388	392	380	364	364	382	417	430	415
35N	337	344	350	346	340	351	350	348	360	352	339	319	314	323	351	351	347	337
25N	312	318	320	312	308	303	308	318	313	295	293	293	292	293	292	299	295	304
15N	286	286	283	277	275	277	279	281	277	275	275	275	279	278	276	277	280	284
5N	262	262	262	262	264	265	264	268	272	276	273	272	274	270	266	265	264	262
EQU	260	261	261	262	263	263	262	266	270	275	271	271	272	268	264	261	260	259
5S	259	260	261	261	262	261	262	266	270	274	270	269	270	266	264	261	258	259
15S	259	260	261	263	264	262	259	266	269	272	267	269	268	266	265	265	263	261
25S	272	271	268	270	270	269	266	269	270	272	269	272	273	274	274	271	273	273
35S	281	282	281	281	281	284	287	291	292	291	289	279	276	280	287	283	281	280
45S	291	293	291	290	290	290	289	294	298	301	300	296	291	295	301	300	294	290
55S	309	309	309	306	303	301	301	307	314	316	317	316	316	321	326	323	314	310
65S	320	318	312	305	300	295	294	298	301	302	308	309	312	316	317	320	321	320
75S	303	299	291	281	276	271	268	268	267	265	268	272	277	278	280	287	293	301
85S	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
MAY(79-91):																		
85N	402	401	401	401	401	401	402	402	401	402	402	403	405	407	407	406	405	403
75N	410	405	406	408	415	414	410	392	399	397	399	404	413	422	426	424	421	415
65N	423	405	387	355	416	430	418	402	398	392	386	388	403	421	425	422	418	422
55N	427	419	404	378	379	404	403	397	393	392	385	378	385	394	402	415	423	424
45N	397	390	380	368	359	374	381	374	379	385	378	370	359	356	361	391	409	404
35N	339	345	346	346	336	347	350	351	359	348	350	335	315	308	307	341	341	335
25N	319	322	322	317	304	315	317	319	312	296	300	298	295	297	296	306	304	312
15N	290	287	283	281	282	283	284	284	282	282	284	284	288	287	284	287	289	291
5N	264	264	265	266	268	267	265	269	273	278	275	274	274	272	270	269	266	265
EQU	260	262	263	263	264	262	262	264	269	274	272	270	269	267	264	261	260	259
5S	258	260	261	262	262	259	258	262	267	274	271	268	267	264	263	260	257	258
15S	260	260	261	262	263	262	256	259	261	266	263	266	267	265	265	264	262	261
25S	273	272	271	273	275	277	272	270	268	268	265	268	268	270	272	271	272	273
35S	290	290	283	281	282	285	285	287	288	289	285	285	285	288	290	292	290	289
45S	311	312	308	304	305	303	299	305	310	313	311	309	310	314	316	314	308	306
55S	321	324	320	313	310	306	303	307	315	321	323	325	327	333	335	330	322	318
65S	323	321	316	308	299	292	287	288	293	298	304	308	314	319	319	318	320	321
75S	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
85S	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
JUNE(79-91):																		
85N	367	367	368	369	370	370	371	370	371	372	371	371	370	370	370	369	369	368
75N	373	368	368	370	377	373	371	362	366	366	365	363	369	372	374	373	373	373
65N	375	365	351	357	369	388	383	376	367	366	357	355	357	365	368	365	362	367
55N	401	395	385	362	361	380	382	379	373	374	369	362	360	366	371	369	379	383
45N	381	374	371	351	336	357	364	357	358	360	362	342	344	343	365	379	380	379
35N	325	327	335	328	316	332	334	336	342	330	331	313	298	292	292	326	327	326
25N	308	311	310	307	300	309	313	314	307	300	300	297	297	294	289	298	299	305
15N	287	285	283	286	285	289	290	290	292	292	291	291	291	285	283	284	285	286
5N	267	267	269	270	272	272	269	274	279	285	279	280	279	275	273	269	267	266
EQU	262	263	264	265	266	266	263	269	274	281	276	272	271	268	265	260	259	260
5S	259	260	262	263	262	262	261	265	269	276	274	268	266	262	259	256	255	256
15S	260	261	262	264	266	265	259	261	261	266	263	264	264	264	263	263	262	261
25S	275	276	276	278	284	284	279	274	271	269	271	270	273	274	274	273	276	278
35S	309	311	308	298	296	298	299	299	297	298	295	292	291	297	303	302	305	310
45S	330	336	332	320	313	311	311	316	317	320	321	318	319	325	331	329	327	327
55S	334	336	330	319	311	306	308	313	317	321	322	323	325	331	336	333	329	330
65S	337	337	330	320	312	307	302	300	302	306	312	313	316	320	323	327	330	331
75S	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
85S	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
JULY(79-91):																		
85N	327	328	330	332	333	333	333	332	331	330	329	328	327	326	325	325	324	326
75N	330	330	332	333	338	340	343	338	336	335	329	323	322	323	320	320	323	328
65N	339	337	327	332	343	355	359	358	351	347	334	330	329	329	326	326	326	333
55N	366	362	361	343	345	361	366	363	356	352	353	344	340	344	345	338	345	357
45N	350	344	349	329	318	340	347	338	342	338	341	325	315	324	325	333	345	357
35N	316	318	323	314	309	323	321	323	326	315	315	297	291	291	285	307	313	316
25N	303	303	302	304	303	308	309	308	305	300	298	294	294	287	285	292	294	296

Table 2. (continued)

15N	284	283	286	290	291	295	295	297	297	294	291	289	290	284	283	282	281	283
5N	269	271	273	276	279	279	278	283	288	292	283	282	281	277	274	270	269	269
EQU	264	266	268	270	272	273	272	278	282	287	281	275	274	270	266	262	262	262
5S	260	262	264	266	268	268	267	272	276	282	277	270	267	263	260	257	256	257
15S	260	261	263	267	269	270	263	267	268	277	270	270	268	266	265	264	262	261
25S	282	284	282	283	287	290	285	286	284	284	276	279	279	280	282	280	282	282
35S	329	330	321	313	314	315	309	309	311	310	305	303	304	310	317	320	323	325
45S	347	352	347	339	337	330	321	322	326	329	327	326	329	336	343	343	341	342
55S	335	341	337	330	324	319	314	318	325	331	331	330	331	339	343	338	337	339
65S	324	327	324	320	314	309	301	301	305	307	311	313	314	317	317	317	317	319
75S	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
85S	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
AUGUST(79-91):																		
85N	291	292	294	295	297	297	297	296	294	295	294	293	292	290	289	288	289	290
75N	301	302	304	306	310	314	316	308	307	306	302	302	302	302	298	296	295	298
65N	318	316	306	310	320	334	338	339	332	325	318	319	321	321	316	314	310	312
55N	338	333	328	317	322	338	345	344	337	333	330	329	330	333	329	320	321	320
45N	327	323	326	315	309	328	331	325	326	326	328	318	309	311	311	313	310	323
35N	308	311	315	308	303	316	312	315	317	311	310	294	288	276	281	301	298	304
25N	296	296	296	300	298	302	302	302	300	297	294	290	291	283	282	288	287	291
15N	281	282	286	290	292	294	294	294	294	292	289	287	289	283	282	280	278	280
5N	272	274	277	280	284	283	282	286	289	294	283	282	281	277	275	272	270	270
EQU	268	270	272	275	278	280	277	283	285	290	284	278	275	271	269	265	264	265
5S	263	266	268	270	273	274	275	278	280	287	281	275	270	265	263	260	259	260
15S	264	265	267	270	272	275	270	275	276	287	277	277	274	271	269	267	265	265
25S	290	291	293	291	294	295	290	293	293	294	287	289	288	290	291	286	288	288
35S	340	340	336	329	327	326	321	323	325	325	320	316	317	323	331	335	338	343
45S	365	362	353	346	343	339	337	344	347	350	349	348	351	357	368	371	368	366
55S	352	346	339	333	327	323	324	332	339	346	352	353	360	370	376	374	363	356
65S	320	316	309	301	295	291	287	289	294	299	303	305	306	308	309	312	317	321
75S	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
85S	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
SEPTEMBER(79-91):																		
85N	268	269	269	268	269	269	270	269	269	268	266	265	263	264	264	264	265	267
75N	300	301	299	294	290	290	293	290	292	290	286	283	280	281	284	286	290	295
65N	322	319	304	303	307	311	313	314	313	308	301	304	303	302	301	306	312	316
55N	336	329	311	298	307	319	324	321	312	303	306	312	314	316	320	328	335	334
45N	318	309	300	297	299	313	310	306	304	305	309	307	302	305	311	328	318	309
35N	295	296	301	298	292	302	298	302	306	303	304	288	285	275	278	296	288	288
25N	287	289	287	288	285	291	292	294	292	289	288	283	285	278	275	282	279	284
15N	279	278	281	284	285	288	288	288	290	289	286	284	284	278	278	277	275	276
5N	271	273	276	279	283	283	282	285	288	292	283	280	278	275	274	271	270	270
EQU	268	271	274	276	280	282	280	286	287	291	284	279	275	271	271	266	265	266
5S	266	268	271	272	276	278	280	284	285	293	286	279	272	268	268	264	262	263
15S	269	270	272	273	277	280	278	285	286	297	287	288	283	279	279	277	275	273
25S	304	302	301	299	299	302	297	302	303	303	298	303	303	302	302	299	299	305
35S	352	350	347	339	333	333	327	332	337	335	329	329	334	335	340	342	342	349
45S	375	374	367	359	350	345	341	350	361	366	365	367	372	379	384	384	378	376
55S	377	369	356	345	334	325	321	330	344	364	378	386	394	402	408	408	398	387
65S	342	329	310	293	279	270	264	264	269	278	291	303	314	323	332	344	351	350
75S	258	253	245	235	229	223	221	223	225	225	229	234	239	240	240	245	249	256
85S	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
OCTOBER(79-91):																		
85N	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
75N	324	322	315	304	295	287	283	275	278	277	273	270	270	274	281	291	306	318
65N	346	341	325	315	311	308	303	301	300	292	285	285	285	290	301	319	334	342
55N	340	336	318	299	308	315	316	313	308	297	293	297	299	303	314	332	353	366
45N	303	301	291	282	292	308	309	299	294	295	294	294	298	300	304	326	359	366
35N	277	281	284	287	288	290	290	283	286	295	293	285	281	274	273	289	278	269
25N	279	281	281	278	274	278	279	284	283	278	275	274	274	271	266	272	268	273
15N	270	268	269	270	272	274	276	275	276	277	277	275	277	271	268	268	266	269
5N	262	263	265	268	272	271	272	275	278	282	275	275	271	268	267	265	263	262
EQU	262	264	266	268	271	272	274	280	280	283	276	275	270	266	265	262	260	260
5S	262	264	267	268	270	272	277	284	281	288	280	278	270	267	267	264	260	260
15S	273	273	274	277	278	278	274	286	289	298	288	292	286	283	280	280	279	277
25S	307	307	303	302	304	299	299	301	302	306	307	307	307	308	307	307	307	309
35S	348	345	341	332	328	322	320	329	332	330	327	329	335	339	345	344	343	346
45S	377	375	370	357	346	340	340	352	360	364	367	368	372	381	389	389	385	380
55S	400	392	383	367	347	331	325	339	356	374	388	396	405	416	424	425	417	408
65S	395	381	358	328	303	284	273	269	277	291	310	328	343	357	373	389	399	401
75S	301	291	271	251	238	226	220	217	216	215	220	228	240	249	258	273	285	297
85S	219	218	214	209	203	201	198	196	196	197	198	201	203	206	209	213	216	218
NOVEMBER(78-91):																		
85N	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
75N	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
65N	380	374	363	358	356	348	330	310	297	285	281	280	282	289	304	332	359	376
55N	371	359	342	330	336	338	324	309	291	285	290	295	299	306	322	353	381	382
45N	325	317	305	300	307	310	302	294	287	291	298	305	307	308	320	345	352	337
35N	272	275	274	277	281	280	276	281	288	294	299	292	284	277	283	295	279	267
25N	264	269	273	272	265	268	272	279	280	274	267	264	263	261	256	257	252	255
15N	260	260	260	258	258	260	263	265	265	263	263	262	263	259	255	255	255	258
5N	254	255	256	257	261	260	260	266	268	273	269	269	263	259	257	252	252	256
EQU	255	257	258	258	260	262	264	271	270	274	268	266	262	259	257	256	255	254
5S	258	261	263	262	263	264	270	277	274	278	271	270	265	262	261	261	259	257
15S	270	273	274	276	277	276	271	283	286	292	280	285	280	275	276	276	276	275
25S	299	300	298	297	297	291	285	295	295	298	292	299	299	298	298	293	295	301
35S	326	326	322	317	315	312	308	316	315	313	313	316	319	322	327	326	323	327
45S	350	347	343	338	334	332	330	336	338	339	343	348	352	355	359	358	353	352
55S	378	374	372	366	359	352	347	349	351	357	364	373	382	388	393	393	389	384
65S	398	393	387	372	355	341	333	329	325	326	334	347	359	375	386	396	400	402
75S	363	360	350	336	324	309	298	291	285	280	284	293	307	319	327	341	351	361
85S	312	312	308	303	296	293	290	285	284	283	283	285	288	293	298	304	308	310
DECEMBER(78-91):																		
85N	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
75N	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
65N	409	395	375	370	371	366	353	343	333	324	321	319	318	324	338	366	391	406
55N	403	379	353	342	355	364	355	337	317	311	317	321	324	330	346	383	415	417
45N	362	345	319	312	326	334	328	314	304	307	320	330	329	342	378	392	422	374
35N	298	292	295	287	289	289	283	284	291	301	312	308	303	290	295	315	299	282
25N	258	264	271	273	264	261	265	275	279	274	266	263	262	258	255	255	247	247
15N	252	254	256	255	251	253	255	258	257	254	253	252	253	249	246	245	244	247
5N	249	250	251	252	254	252	252	259	262	266	263	258	256	253	251	249	248	248
EQU	251	252	254	254	254	254	256	263	265	269	265	261	257	254	253	250	250	250
5S	255	256	259	259	258	258	262	270	270	273	266	264	260	257	257	257	254	254
15S	268	268	270	274	273	270	266	277	282	285	274	275	274	270	270	270	271	270
25S	287	288	286	286	286	282	275	284	286	289	284	288	288	287	287	281	284	288
35S	305	307	306	301	300	298	295	301	300	299	300	301	300	300	305	305	303	307
45S	318	316	318	320	321	320	318	327	332	332	330	329	325	326	332	330	325	323
55S	333	331	336	339	341	340	338	348	357	361	362	360	359	360	360	356	347	341
65S	345	343	344	343	344	345	344	344	349	351	353	356	356	359	362	359	356	351
75S	346	342	338	335	338	337	336	335	337	333	333	334	340	342	342	345	348	351
85S	335	334	332	330	328	331	331	330	331	330	330	330	330	331	333	335	335	336
CLIMATOLOGY(JAN79-DEC91):																		
85N	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
75N	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
65N	395	386	371	373	381	387	377	365	356	348	343	344	348	359	369	382	391	395
55N	396	385	369	353	362	378	373	362	348	345	348	348	351	359	371	390	406	404
45N	366	354	344	333	336	351	349	337	333	338	344	343	340	340	348	373	383	376
35N	310	313	314	313	310	316	312	314	320	319	324	314	305	295	298	320	314	308
25N	285	290	293	292	285	288	290	296	296	288	285	282	281	278	275	280	275	279
15N	271	271	272	272	271	273	275	277	276	274	273	272	274	270	268	267	266	268
5N	260	261	262	264	267	266	265	270	274	278	272	270	270	266	264	261	259	259
EQU	259	261	263	263	265	265	265	270	273	278	271	269	267	264	262	258	258	258
5S	259	261	263	263	264	264	266	272	274	279	273	269	266	263	261	259	257	257
15S	263	265	267	269	270	270	265	273	276	281	273	274	272	269	269	268	267	266
25S	283	284	283	284	284	284	279	283	283	285	280	284	283	284	284	280	282	285
35S	312	312	309	304	303	303	300	303	304	303	301	300	301	305	309	309	308	312
45S	329	329	327	323	320	318	315	321	326	329	329	327	327	332	338	337	332	329
55S	338	337	334	330	325	321	318	324	332	340	345	346	348	354	358	357	349	342
65S	338	334	327	319	312	306	301	301	304	310	317	321	326	331	335	339	341	340
75S	959	999	959	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
85S	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999

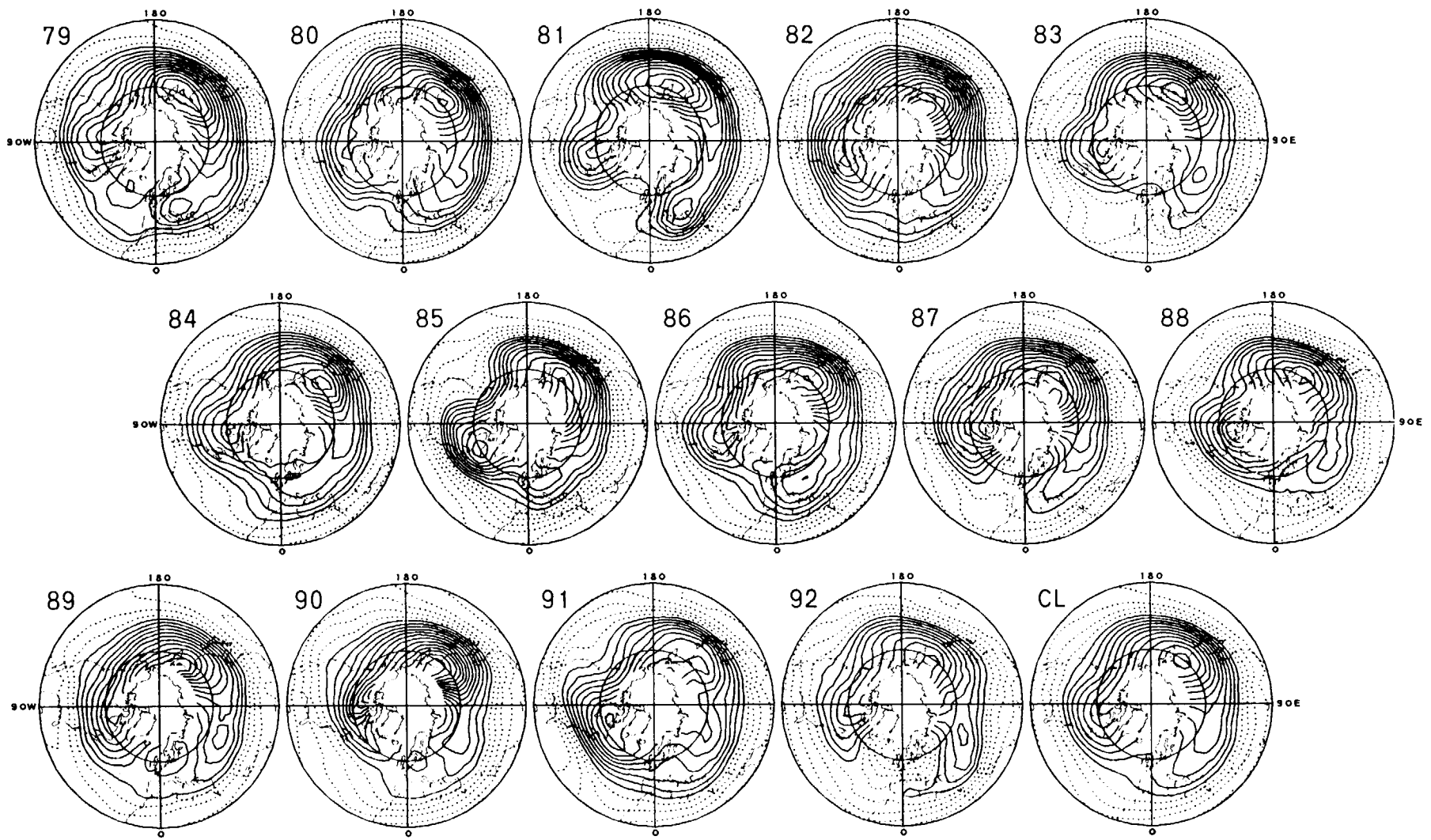


Figure 4. Monthly mean polar stereographic TOMS ozone (units DU) for seasonal months indicated [January, April, July, October] and in hemisphere indicated [Northern Hemisphere (NH), Southern Hemisphere (SH)]. Concentric circles: latitudes 20 and 55°. Dashed (solid) contours begin at 300 (315) and decrement (increment) by 15. Climatology fields for each month, denoted "CL", were computed by averaging TOMS over the years shown.

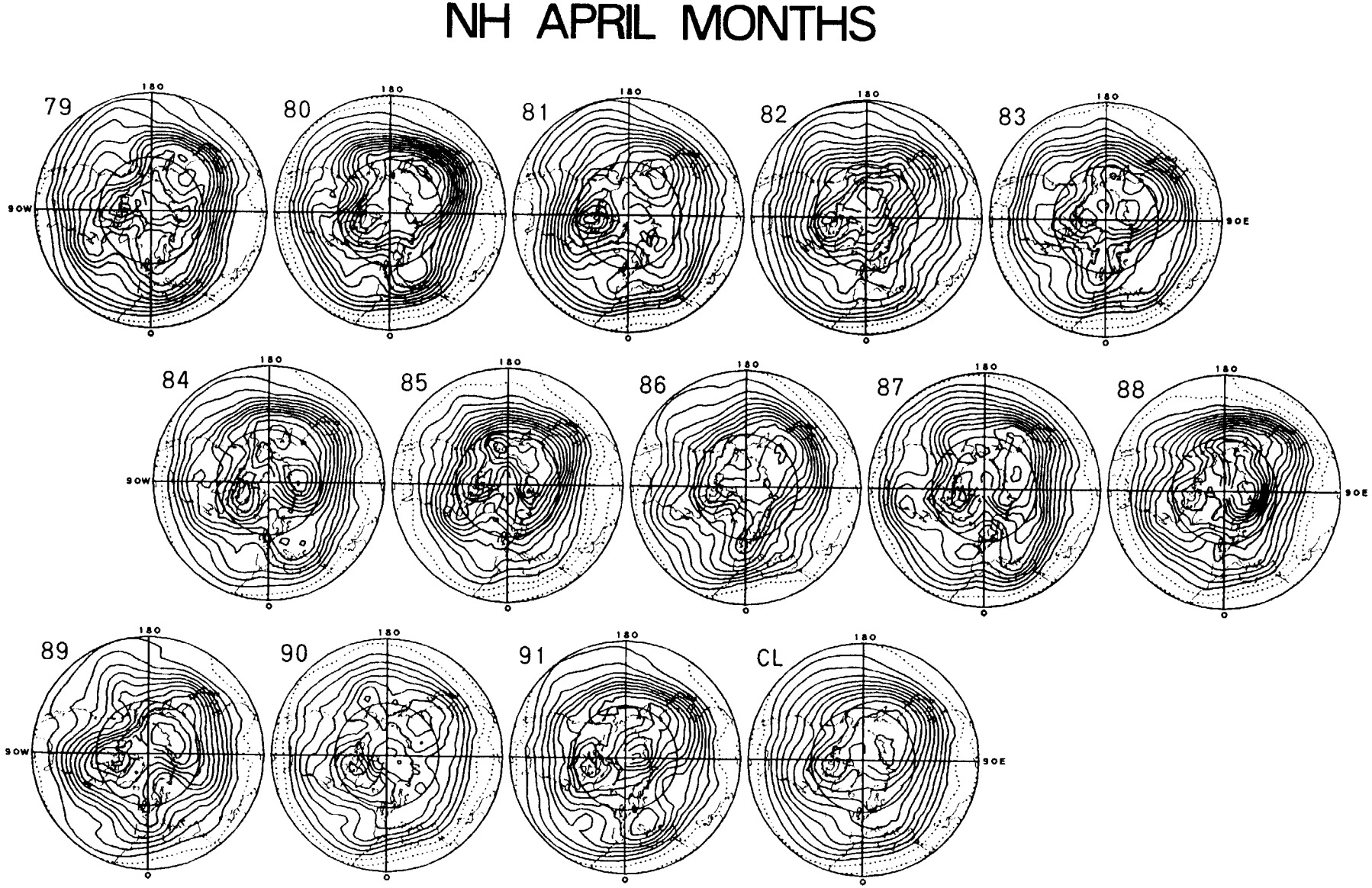


Figure 4. (continued)

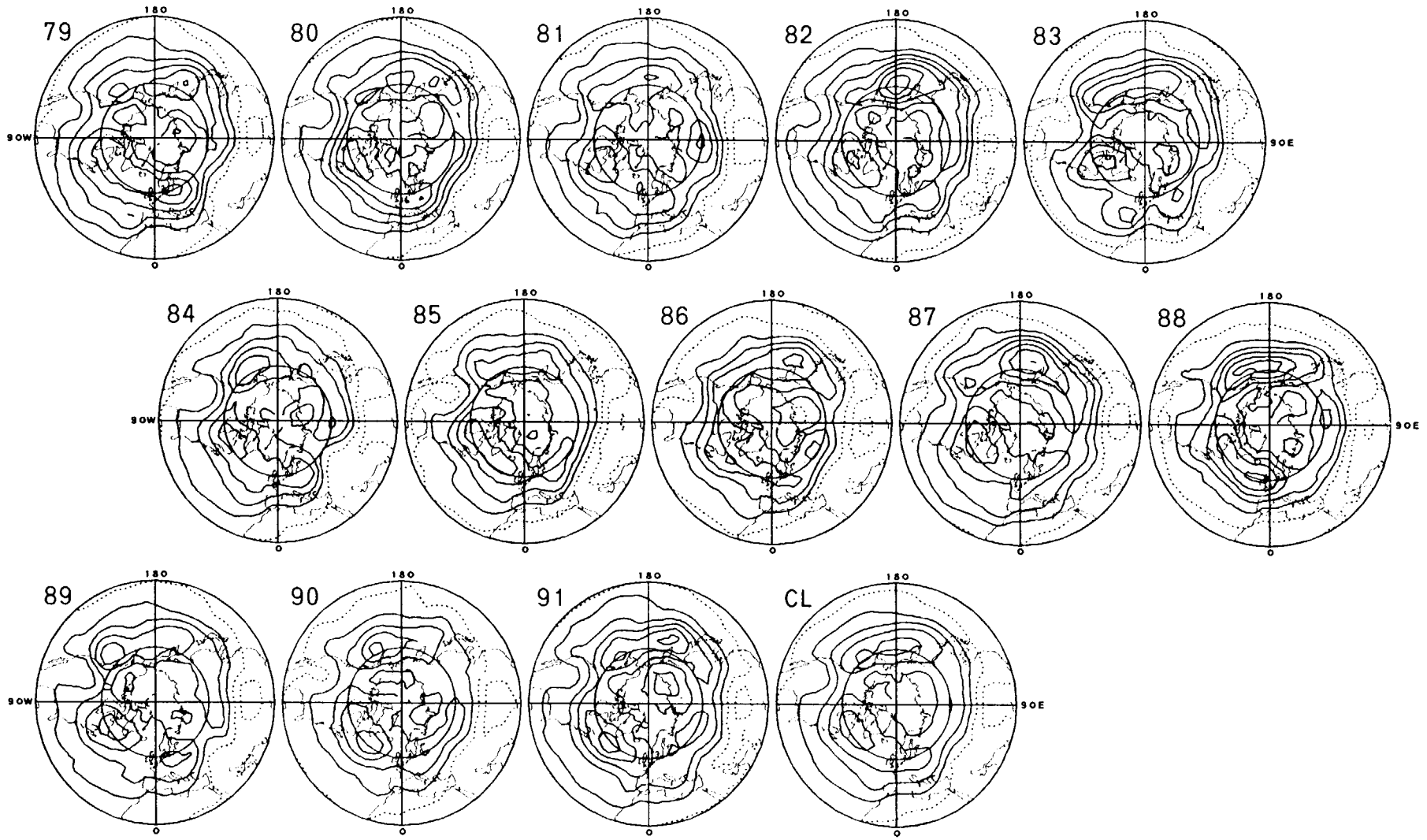


Figure 4. (continued)

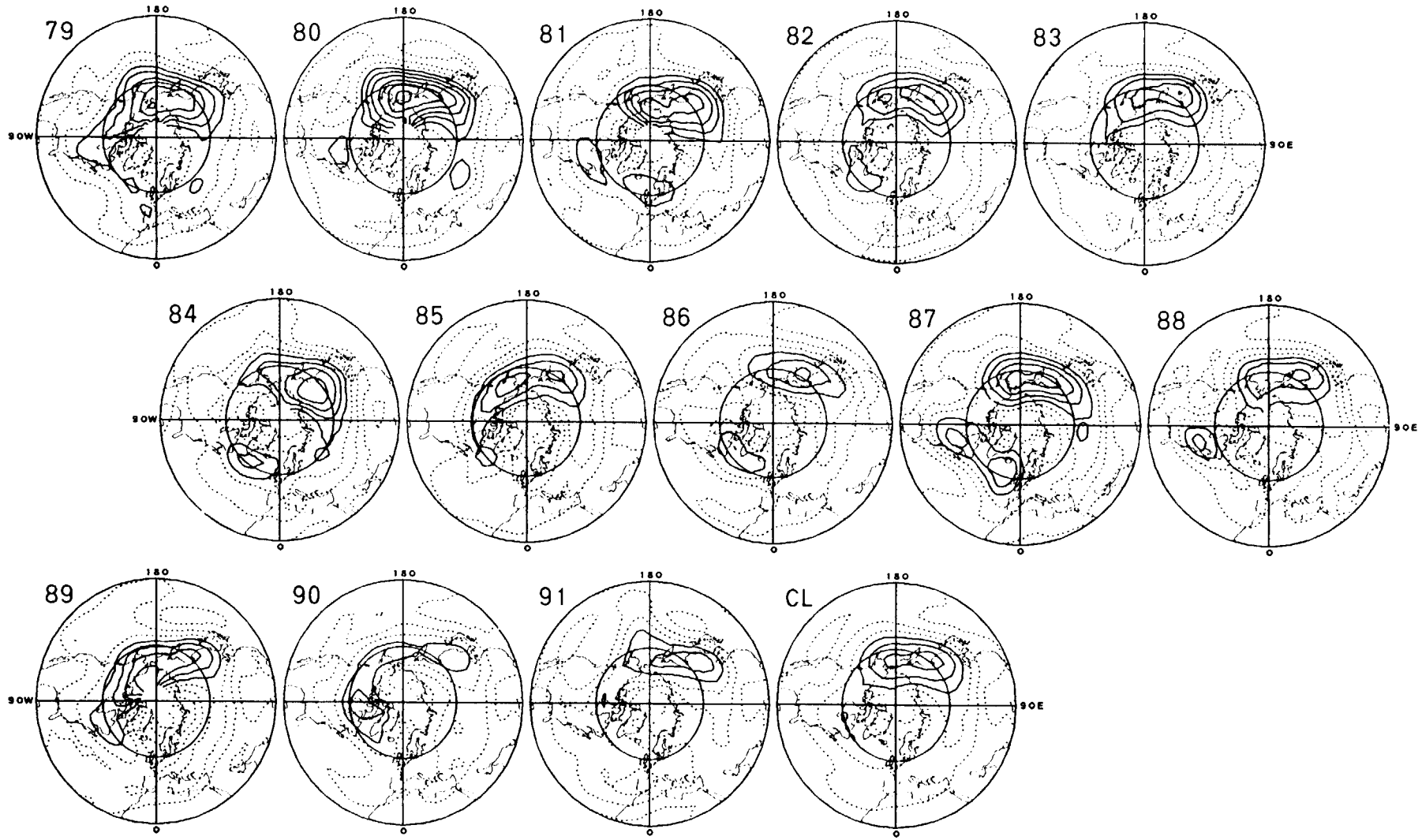


Figure 4. (continued)

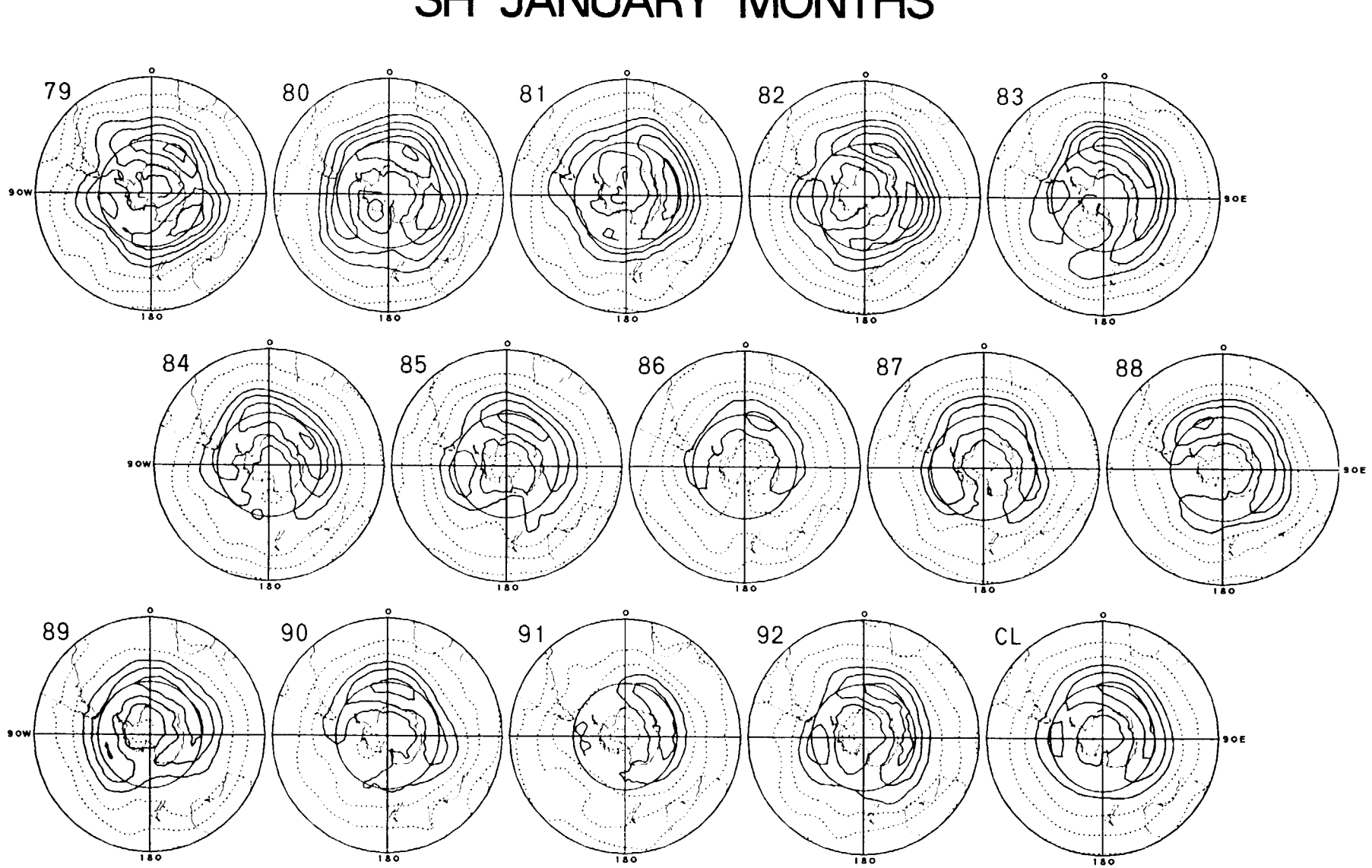


Figure 4. (continued)

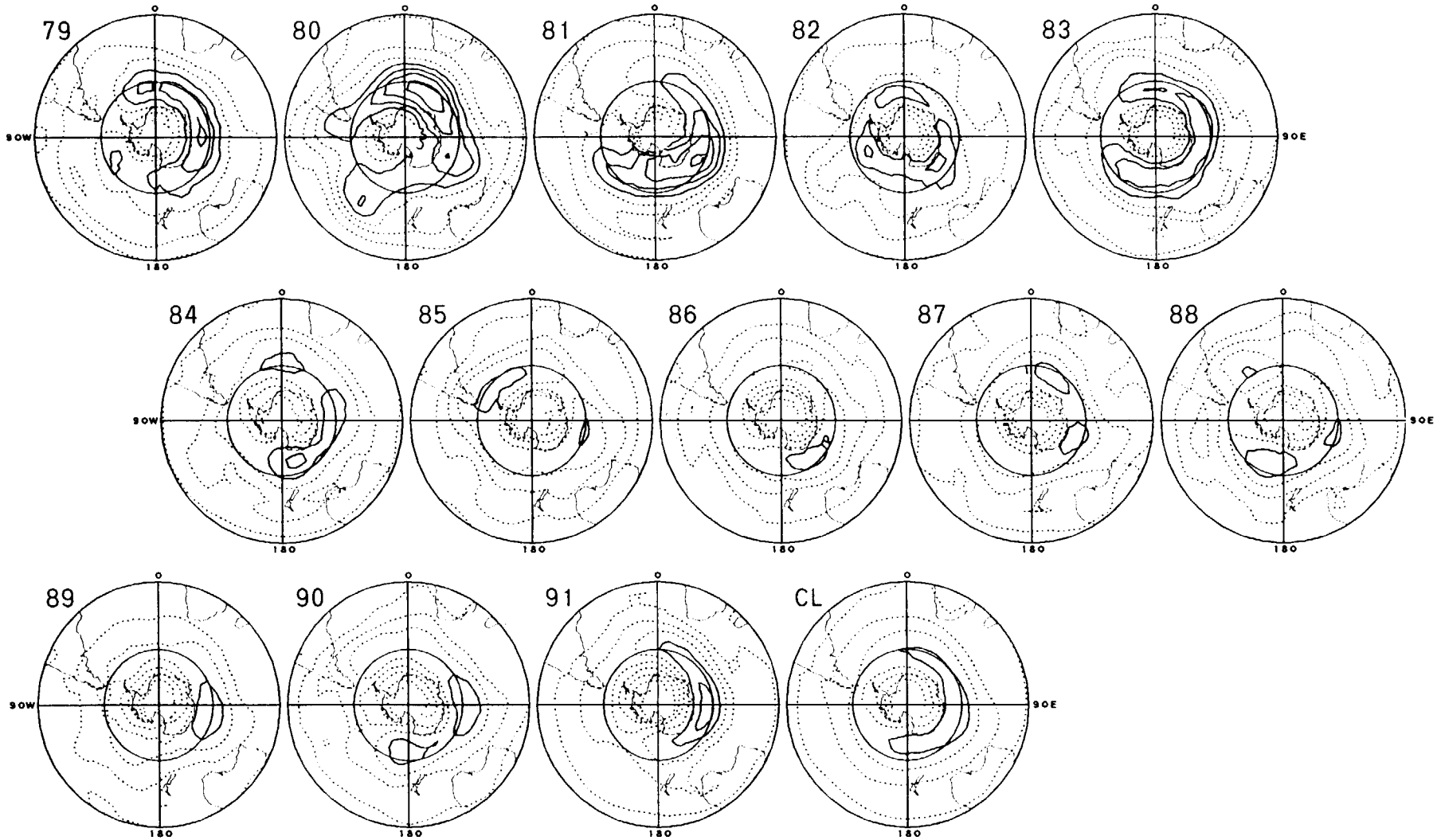


Figure 4. (continued)

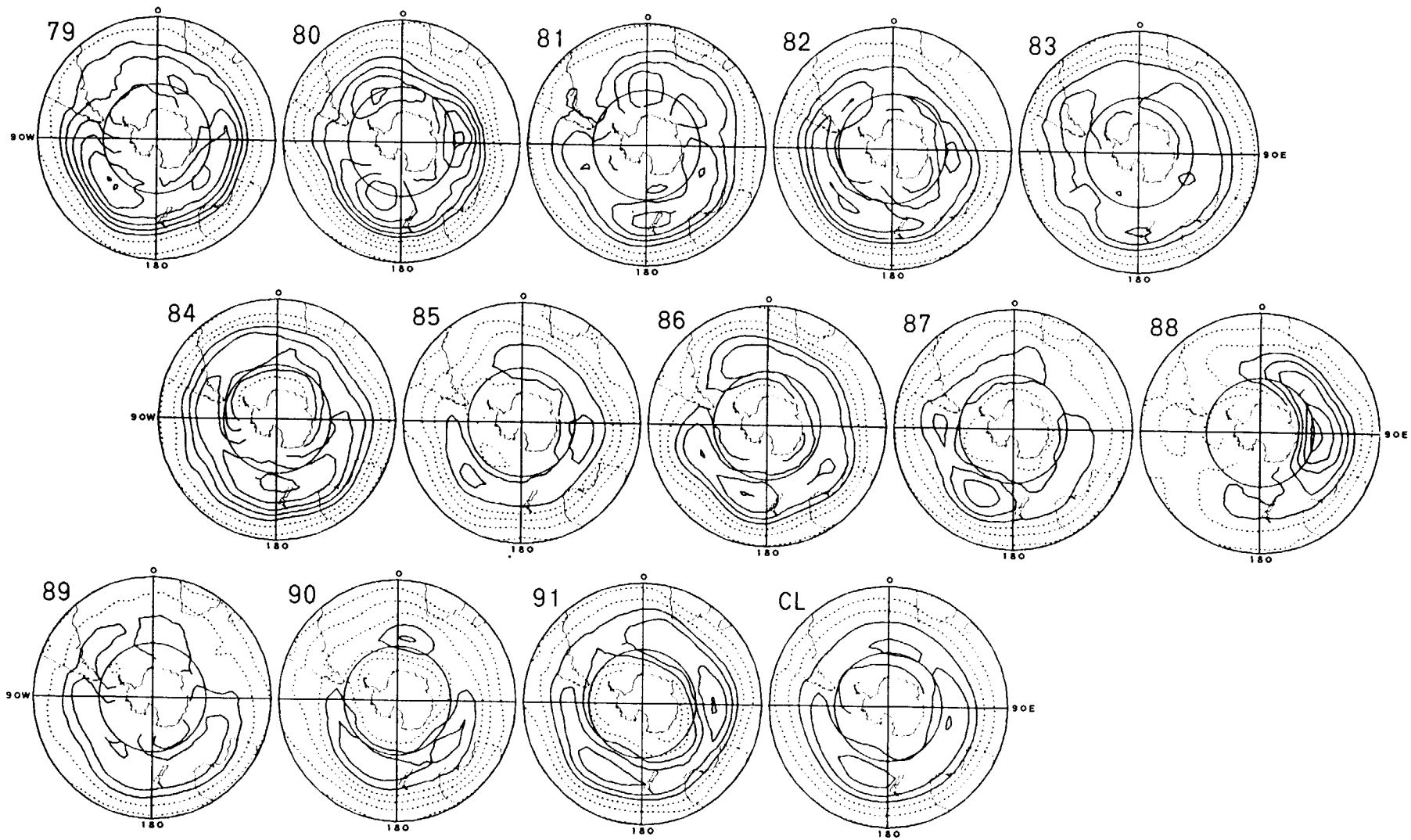


Figure 4. (continued)

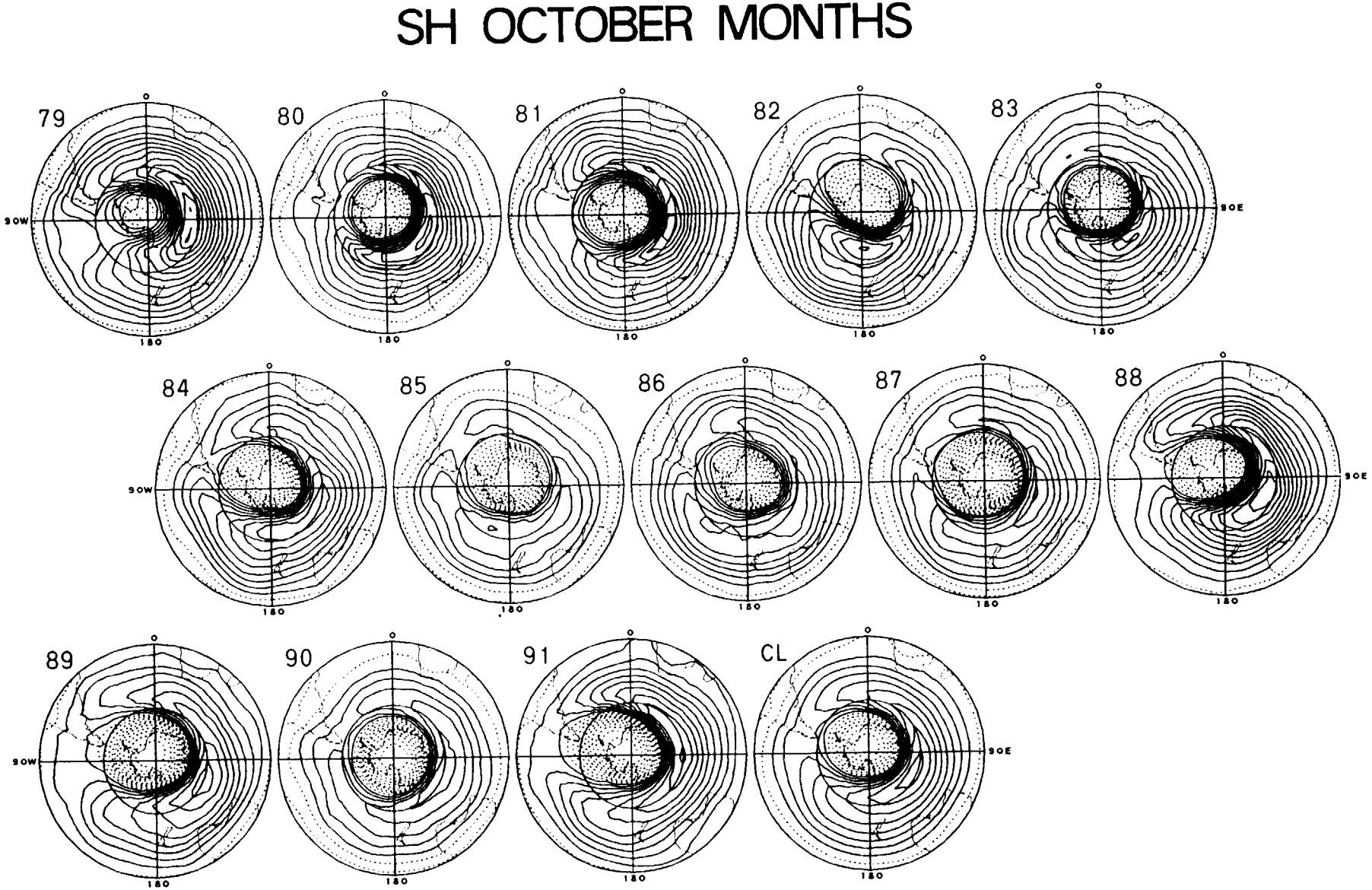


Figure 4. (continued)

Table 3. Monthly Mean TOMS for 1979-1991: Zonal Waves 0-7

ZONAL WAVE-0 AMPLITUDE(DU)

LATITUDE

	85N	75N	65N	55N	45N	35N	25N	15N	5N	EQU	5S	15S	25S	35S	45S	55S	65S	75S	85S
1978:																			
N	999	999	332	322	302	284	273	268	264	264	268	281	298	322	352	387	401	386	382
D	999	999	344	351	336	297	273	260	257	257	261	274	288	312	335	361	370	359	345
1979:																			
J	999	999	392	398	382	332	277	255	250	252	257	268	278	296	320	348	342	326	313
F	999	999	459	441	408	344	286	263	252	253	257	264	272	288	307	326	328	306	289
M	999	502	481	439	410	357	303	275	263	262	263	266	273	288	301	314	315	304	280
A	482	463	448	430	405	355	315	289	270	266	265	269	276	290	299	319	320	290	999
M	407	424	420	410	389	348	315	292	271	264	263	269	280	299	315	327	314	999	999
J	377	377	379	383	364	332	310	291	271	263	262	272	283	313	341	338	334	999	999
J	336	332	346	359	342	315	302	291	275	267	264	273	290	324	356	353	342	999	999
A	306	314	328	337	322	309	299	291	279	273	270	278	298	345	369	358	329	999	999
S	274	304	318	325	312	300	291	287	276	273	274	286	312	353	382	380	342	287	999
O	999	307	322	325	306	285	277	271	263	262	265	282	310	347	388	420	409	346	302
N	999	999	354	337	313	285	272	259	258	261	266	282	306	337	366	396	399	368	355
D	999	999	382	367	338	298	264	250	255	260	263	277	296	316	346	376	373	362	366
1980:																			
J	999	999	404	404	376	318	265	247	256	262	265	274	286	303	329	356	350	333	329
F	999	999	428	433	412	331	269	247	258	262	263	270	278	292	313	334	335	320	305
M	999	489	471	455	409	343	280	254	263	265	264	265	271	286	305	322	327	319	299
A	483	483	460	439	404	343	298	267	269	270	266	260	270	287	309	331	329	304	999
M	425	425	423	415	390	345	308	280	274	274	270	258	267	287	320	347	347	999	999
J	380	382	378	386	366	329	305	288	279	277	271	255	266	300	331	351	355	999	999
J	339	344	347	361	341	314	301	292	287	284	277	260	269	309	343	358	344	999	999
A	325	315	323	338	326	308	296	292	290	288	282	268	284	317	352	370	332	999	999
S	276	301	315	328	313	297	290	288	290	289	284	276	293	328	361	388	329	265	999
O	999	305	321	326	308	287	280	277	279	279	278	279	295	326	360	399	374	279	236
N	999	999	338	339	320	288	270	267	270	270	272	277	293	314	345	382	380	339	324
D	999	999	354	353	345	308	270	260	261	263	265	272	284	301	330	361	371	364	351
1981:																			
J	999	999	371	383	382	324	272	261	259	262	265	270	278	295	320	344	339	328	315
F	999	999	445	433	401	334	282	258	256	259	262	266	273	286	305	325	327	303	285
M	999	466	448	438	409	344	292	270	263	265	266	267	274	286	296	318	319	296	262
A	428	443	443	427	399	352	307	283	268	266	266	266	274	282	300	323	322	309	999
M	402	411	406	406	392	346	309	287	269	265	264	267	274	294	316	329	333	999	999
J	374	374	367	380	369	323	301	286	271	265	263	268	282	311	323	326	335	999	999
J	331	337	341	351	336	313	300	288	273	268	265	271	293	324	341	338	337	999	999
A	300	304	320	330	324	306	295	289	277	272	269	275	300	339	364	356	327	999	999
S	275	292	312	322	313	294	287	284	274	272	273	283	307	345	385	394	332	279	999
O	999	304	320	320	307	286	280	275	266	265	269	285	311	348	382	413	360	273	239
N	999	999	343	341	320	285	272	265	257	257	263	283	302	328	350	380	388	343	314
D	999	999	386	371	346	299	271	255	250	251	258	278	290	308	331	356	366	359	353
1982:																			
J	999	999	429	423	389	326	276	250	245	247	253	269	279	297	322	348	335	316	309
F	999	999	443	443	412	347	288	257	248	249	255	269	275	289	306	328	326	300	285
M	999	448	455	444	406	357	310	273	256	256	259	270	275	286	296	313	319	300	274
A	493	481	457	428	397	356	316	283	262	258	259	267	278	288	293	304	321	292	999
M	417	430	425	415	386	347	317	283	267	261	259	264	281	296	313	313	308	999	999
J	370	376	377	388	370	329	311	288	277	270	264	262	280	310	330	316	314	999	999
J	333	335	344	360	346	316	302	289	284	278	269	267	281	316	338	333	319	999	999
A	286	309	331	342	324	308	297	286	287	284	275	269	288	324	350	351	307	999	999
S	255	298	320	321	311	300	287	282	285	284	278	275	297	332	357	363	315	255	999
O	999	292	317	319	304	289	275	268	275	276	276	277	298	332	367	377	351	254	250
N	999	999	326	328	309	284	267	256	267	271	273	277	295	320	347	373	367	316	273
D	999	999	339	346	329	292	259	245	258	263	266	274	289	303	328	354	354	344	343
1983:																			
J	999	999	370	375	348	301	258	243	252	259	263	270	281	299	321	342	332	319	317
F	999	999	399	401	379	320	265	245	249	257	263	268	276	292	309	323	324	307	300
M	999	443	438	414	386	333	277	256	254	260	265	267	273	285	301	315	320	306	275
A	447	445	425	407	384	339	296	271	262	264	266	265	270	282	300	323	325	284	999
M	403	406	400	393	373	333	304	282	265	262	261	264	273	287	312	329	322	999	999
J	377	365	356	368	361	321	299	283	269	263	260	267	281	304	325	329	323	999	999
J	317	326	334	348	337	309	294	282	271	265	261	269	289	321	335	334	329	999	999
A	278	300	319	326	317	303	293	284	275	270	266	272	295	333	353	342	321	999	999
S	272	289	305	315	307	291	283	280	273	271	270	280	304	343	375	377	315	243	999
O	999	285	310	314	300	282	275	272	265	265	268	283	309	339	367	388	355	253	203
N	999	999	326	328	315	280	264	260	255	255	260	277	298	322	342	366	373	344	325
D	999	999	354	362	347	299	267	254	248	249	255	273	286	303	323	349	350	341	338
1984:																			
J	999	999	385	393	371	321	276	252	244	246	253	268	278	295	315	335	330	316	311
F	999	999	408	408	393	332	284	257	247	248	253	266	273	288	303	319	320	300	289
M	999	477	452	431	412	351	291	263	250	249	251	260	268	282	293	310	309	293	272
A	437	459	446	421	396	347	308	279	260	255	255	263	274	284	296	312	306	282	999
M	415	413	407	403	386	340	309	284	261	253	253	262	276	294	320	326	303	999	999
J	380	372	369	378	359	321	303	285	262	254	252	261	278	310	341	342	329	999	999
J	337	331	337	349	331	309	299	286	267	260	256	263	288	330	352	341	317	999	999
A	290	307	319	325	317	303	294	285	272	266	263	267	295	341	369	352	300	999	999
S	256	283	308	321	308	293	285	279	273	271	271	276	306	351	376	365	308	235	999
O	999	294	316	324	301	280	271	266	267	268	270	278	305	337	370	382	336	254	207
N	999	999	334	336	313	275	255	251	259	264	266	272	293	316	347	375	374	321	283
D	999	999	370	362	333	289	252	242	258	263	265	270	284	304	328	347	344	332	312
1985:																			
J	999	999	409	391	362	290	244	239	256	260	262	265	274	290	312	331	326	310	295
F	999	999	428	415	378	304	253	244	261	266	267	265	269	283	301	320	315	294	279
M	999	462	446	420	378	308	270	257	267	270	269	265	266	279	289	308	311	286	248
A	432	460	449	418	366	321	288	273	274	275	271	261	264	276	291	307	304	272	999

Table 3. (continued)

M	404	406	408	398	364	328	299	282	277	275	271	258	260	277	299	312	297	999	999
J	365	362	364	376	355	313	294	287	280	277	270	255	263	283	312	317	303	999	999
J	321	329	339	350	328	305	294	289	285	281	274	260	270	298	322	312	304	999	999
A	293	303	319	327	316	298	291	287	287	285	278	266	277	309	331	332	301	999	999
S	254	282	308	314	305	291	284	284	286	284	280	274	288	320	342	345	296	222	999
O	999	282	307	315	295	282	277	274	277	276	275	276	292	323	345	349	303	223	177
N	999	999	315	325	317	288	268	262	264	264	266	276	286	303	325	347	336	285	250
D	999	999	349	364	349	299	263	255	254	255	258	268	275	289	305	325	332	324	319
1986:																			
J	999	999	394	399	374	314	265	251	248	250	255	261	268	282	300	316	313	299	287
F	999	999	387	411	397	331	281	260	253	256	259	263	265	278	293	308	300	279	270
M	999	441	433	416	387	337	292	271	259	259	260	261	266	276	285	300	293	269	240
A	457	449	435	413	384	339	305	280	261	259	258	260	263	272	287	304	293	259	999
M	389	401	407	391	367	332	306	284	264	259	258	260	263	281	309	321	300	999	999
J	358	359	357	369	351	315	298	284	268	261	258	262	272	298	324	324	316	999	999
J	322	321	330	346	330	304	295	285	273	266	261	267	278	314	339	330	308	999	999
A	298	300	315	326	314	298	289	281	271	266	263	272	289	332	364	363	313	999	999
S	260	287	307	309	304	290	283	279	270	269	269	281	301	340	370	372	318	236	999
O	999	279	303	310	298	284	276	271	264	264	267	281	303	338	372	379	337	247	194
N	999	999	318	332	320	284	264	259	252	252	257	276	294	314	341	365	361	343	332
D	999	999	361	355	335	290	264	254	248	248	254	270	282	299	319	344	348	337	328
1987:																			
J	999	999	400	385	361	303	263	249	243	244	250	265	273	286	307	329	327	314	300
F	999	999	461	416	385	317	270	249	241	241	246	257	266	280	298	314	312	299	292
M	999	460	449	435	405	342	288	263	252	250	252	262	270	279	289	302	310	296	256
A	432	449	436	422	396	355	307	278	260	255	256	263	271	279	285	306	308	276	999
M	411	412	418	408	383	348	314	285	262	255	253	258	272	283	299	306	297	999	999
J	372	379	376	380	363	332	308	287	267	260	256	256	272	293	316	321	309	999	999
J	328	335	345	357	344	316	299	287	276	271	264	258	281	310	324	316	296	999	999
A	297	307	326	339	328	309	295	285	282	281	275	266	285	322	337	330	283	999	999
S	284	299	315	323	311	298	285	280	285	286	281	273	295	332	356	348	261	199	999
O	999	293	315	325	308	282	271	268	278	281	279	278	299	333	360	365	277	182	149
N	999	999	342	340	314	276	256	254	270	274	274	275	293	323	344	355	300	220	192
D	999	999	376	353	326	277	246	244	259	263	265	269	279	290	314	336	338	328	323
1988:																			
J	999	999	393	372	345	288	248	244	257	261	264	269	274	286	311	332	323	306	293
F	999	999	415	403	371	312	263	248	259	263	266	268	272	284	297	316	317	256	278
M	999	463	446	430	393	320	275	261	260	261	262	262	266	278	286	303	308	289	264
A	465	469	448	414	380	327	288	275	265	264	264	263	266	275	289	307	300	276	999
M	385	403	410	399	376	327	297	284	270	266	263	262	269	282	300	308	295	999	999
J	360	364	361	368	359	320	294	285	273	268	264	268	277	294	306	306	303	999	999
J	317	323	332	354	335	304	293	285	273	268	264	272	285	308	324	325	301	999	999
A	284	294	314	329	315	297	286	279	271	268	265	275	289	330	362	361	312	959	999
S	278	294	297	310	306	289	279	276	269	268	269	286	305	339	375	389	330	252	999
O	999	287	295	305	300	278	272	269	264	265	268	286	304	333	375	401	363	289	246
N	999	999	321	320	307	277	265	260	255	256	263	280	296	314	339	375	388	372	363
D	999	999	347	351	336	296	265	259	253	254	260	276	285	301	324	353	356	348	342
1989:																			
J	999	999	387	378	354	307	270	262	254	256	262	275	280	295	313	335	333	317	299
F	999	999	430	415	369	318	280	263	255	256	259	268	272	287	303	318	319	295	270
M	999	490	455	419	374	325	294	274	264	263	263	267	271	284	292	306	307	282	245
A	441	443	430	411	381	337	310	287	270	266	265	270	276	282	293	307	300	269	999
M	394	406	398	388	373	337	313	293	270	263	262	268	277	289	306	313	308	999	999
J	367	364	356	367	356	322	307	293	273	264	262	270	284	300	316	320	317	999	999
J	328	324	329	344	336	312	304	293	274	266	263	273	293	317	327	322	318	999	999
A	279	294	317	327	319	305	300	292	276	269	268	278	306	338	348	328	288	999	999
S	260	281	305	313	308	295	291	289	277	274	275	289	315	347	365	348	264	201	999
O	999	299	307	312	299	284	280	279	268	267	272	290	313	343	367	367	296	203	163
N	999	999	330	326	306	280	266	259	256	257	263	280	298	322	349	369	353	292	255
D	999	999	349	352	338	292	261	248	255	259	263	276	289	302	322	340	334	327	322
1990:																			
J	999	999	385	366	348	303	263	244	255	261	264	272	278	289	309	329	321	308	303
F	999	999	423	401	359	314	273	250	259	263	265	269	274	284	294	312	319	297	271
M	999	378	418	402	367	326	285	263	270	274	273	270	273	282	292	304	302	280	251
A	360	387	399	387	370	337	297	275	277	279	277	266	269	279	295	308	295	267	999
M	388	389	382	374	362	329	301	283	280	279	275	260	263	277	304	317	291	999	999
J	353	357	355	361	347	314	298	287	282	279	273	254	263	286	307	307	299	999	999
J	331	322	328	342	326	306	298	291	287	284	277	258	270	299	321	314	284	999	999
A	274	295	313	325	317	300	293	290	290	287	279	264	275	309	337	334	274	999	999
S	268	280	300	313	303	292	286	285	288	287	283	273	286	319	346	350	284	205	999
O	999	265	301	308	292	283	276	276	280	281	279	277	296	324	350	363	300	191	155
N	999	999	315	316	303	295	268	265	269	269	271	276	292	310	333	349	317	244	198
D	999	999	356	342	327	294	263	256	258	258	261	268	281	294	311	325	319	299	287
1991:																			
J	999	999	406	391	366	312	263	248	251	253	256	262	270	282	296	315	319	305	288
F	999	999	426	413	393	328	272	252	255	259	262	264	267	275	292	313	311	280	267
M	999	441	436	427	392	341	293	270	265	267	268	267	268	278	282	297	301	285	246
A	472	446	427	416	394	345	309	283	269	267	266	263	269	275	287	307	296	262	999
M	398	404	404	401	383	347	317	290	270	264	263	263	269	286	303	307	292	999	999
J	375	375	366	379	363	329	312	292	275	268	264	263	276	305	320	308	296	999	999
J	334	334	338	357	343	316	307	294	281	272	267	272	286	324	338	317	287	999	999
A	299	308	321	334	321	307	297	291	279	266	261	278	301	336	360	347	271	999	999
S	259	280	307	320	307	294	286	282	272	263	259	280	309	346	373	365	282	205	999
O	999	277	298	303	296	284	277	271	261	255	258	287	313	344	372	375	316	214	163
N	999	999	298	308	304	276	265	254	248	247	253	279	301	321	348	369	362	320	304
D	999	999	330	327	317	289	263	243	243	247	254	273	288	304	328	347	346	331	316
1992:																			
J	999	999	359	350	343	305	265	242	242	247	254	269	277	291	311	333	329	307	292

Table 3. (continued)

ZONAL WAVE-1 AMPLITUDE(DU)

LATITUDE

	85N	75N	65N	55N	45N	35N	25N	15N	5N	EQU	5S	15S	25S	35S	45S	55S	65S	75S	85S
1978:																			
N	999	999	11	19	19	10	13	3	6	7	7	6	4	9	7	17	17	20	11
D	999	999	35	44	34	15	6	5	5	5	4	3	4	9	8	23	8	4	7
1979:																			
J	999	999	64	69	43	5	6	4	4	4	3	3	1	3	7	11	9	11	4
F	999	999	59	46	14	6	6	1	3	4	4	3	1	3	5	13	15	15	8
M	999	5	18	38	33	4	13	8	7	6	7	5	2	2	7	8	15	16	10
A	9	16	11	12	4	22	13	6	7	7	6	4	5	7	7	18	15	12	999
M	10	16	9	20	20	12	10	3	5	5	5	3	4	2	7	13	19	999	999
J	9	13	14	13	9	12	8	0	6	7	7	1	6	11	12	14	20	999	999
J	7	9	11	4	7	15	9	7	8	9	9	4	10	11	24	26	23	999	999
A	13	12	15	5	8	16	8	8	9	11	11	9	4	14	15	25	10	999	999
S	3	7	4	12	10	7	4	6	8	11	12	9	3	11	26	46	52	22	999
O	999	46	42	22	4	10	3	5	8	9	10	7	5	10	32	61	73	56	21
N	999	999	65	48	28	2	8	3	9	11	10	7	6	13	6	14	20	29	8
D	999	999	31	10	19	10	5	6	9	9	8	5	4	7	12	27	15	5	5
1980:																			
J	999	999	51	51	48	15	11	8	6	8	8	5	1	1	6	12	19	14	6
F	999	999	69	51	45	7	7	2	5	6	6	6	3	1	2	12	20	19	14
M	999	47	45	40	28	5	5	1	6	6	6	6	3	4	8	24	24	17	9
A	10	12	22	48	19	16	12	5	8	7	7	6	4	7	2	21	26	25	999
M	4	16	20	19	9	15	11	5	7	6	7	5	3	6	7	23	35	999	999
J	5	9	3	1	5	16	7	5	9	9	8	5	2	8	9	11	15	999	999
J	10	12	19	16	4	14	10	8	9	10	10	9	5	14	17	9	8	999	999
A	4	9	11	4	2	11	9	7	8	10	12	9	4	8	9	7	8	999	999
S	5	5	10	7	6	9	8	7	7	9	11	8	3	5	19	38	25	13	999
O	999	44	44	34	12	13	7	4	6	9	11	8	2	8	22	43	72	42	11
N	999	999	48	39	25	7	8	3	6	7	7	6	3	4	21	42	47	43	20
D	999	999	21	34	36	6	12	6	7	8	7	4	3	7	9	23	16	3	2
1981:																			
J	999	999	48	67	58	12	17	11	7	7	6	6	1	2	11	15	14	10	2
F	999	999	43	53	43	7	15	9	7	7	7	7	5	2	5	6	6	3	4
M	999	18	15	28	28	4	1	4	7	6	6	5	4	3	5	8	20	18	6
A	16	21	22	19	9	2	11	5	5	5	5	2	4	9	6	21	31	40	999
M	5	15	5	7	9	15	7	3	4	3	3	3	5	10	2	6	15	999	999
J	5	5	15	22	19	8	8	3	6	6	6	1	7	7	9	9	4	999	999
J	7	10	12	5	7	16	9	7	7	8	9	2	3	10	14	8	2	999	999
A	12	22	15	3	5	15	9	8	7	9	10	8	6	8	26	21	5	999	999
S	9	25	24	17	5	10	8	7	8	10	12	9	2	7	20	48	36	10	999
O	999	35	26	16	8	5	5	7	9	11	12	9	2	4	21	52	58	22	7
N	999	999	79	55	25	12	9	4	9	9	9	5	3	9	20	26	48	42	12
D	999	999	83	60	30	12	14	7	8	8	8	6	3	1	5	16	12	8	6
1982:																			
J	999	999	78	52	30	8	9	4	5	6	6	4	2	1	6	17	16	11	4
F	999	999	12	7	25	21	15	7	7	6	6	5	3	4	7	13	18	18	8
M	999	45	37	34	15	6	10	3	7	8	8	5	3	0	5	11	18	21	11
A	15	32	37	36	19	12	11	5	6	7	7	5	2	2	6	6	5	18	999
M	4	13	18	15	15	16	14	4	4	4	4	3	3	9	14	15	9	999	999
J	8	6	7	8	11	13	6	4	8	8	8	5	4	11	14	4	6	999	999
J	5	11	15	12	9	12	9	8	9	10	11	10	4	20	21	2	4	999	999
A	4	14	21	13	8	14	7	8	11	12	14	10	3	12	15	19	16	999	999
S	19	21	11	11	9	7	5	6	8	10	11	11	9	15	19	42	50	18	999
O	999	9	18	20	10	7	3	2	7	8	10	10	9	19	30	55	97	88	29
N	999	999	45	42	23	12	7	4	6	5	6	7	5	1	10	20	23	20	8
D	999	999	51	65	37	9	12	7	5	7	6	3	3	3	11	13	6	3	3
1983:																			
J	999	999	43	57	42	13	17	6	5	6	4	5	3	4	7	25	24	11	2
F	999	999	66	65	45	10	13	5	6	6	5	7	2	6	2	20	27	14	5
M	999	29	31	47	44	6	6	2	8	8	5	7	4	2	4	8	17	15	9
A	8	19	28	31	13	12	10	6	10	9	6	5	3	0	1	9	15	17	999
M	2	8	11	14	13	12	9	8	6	6	5	4	7	3	3	12	24	999	999
J	1	5	4	14	18	13	7	3	6	7	5	6	4	4	2	9	7	999	999
J	1	6	10	14	10	12	8	7	9	9	10	1	3	5	5	6	14	999	999
A	1	10	13	4	6	13	8	8	9	10	10	4	1	10	19	32	16	999	999
S	12	10	10	5	6	9	7	7	9	11	12	8	1	2	13	34	19	1	999
O	999	30	26	26	13	11	7	6	8	10	11	8	4	13	19	37	78	56	16
N	999	999	61	52	26	12	11	4	9	10	11	6	2	9	16	23	40	52	21
D	999	999	61	55	35	8	10	4	8	9	9	6	2	5	8	19	13	9	5
1984:																			
J	999	999	43	38	38	13	13	8	8	8	9	8	2	4	9	21	21	9	1
F	999	999	103	75	48	9	19	8	8	8	9	9	5	3	6	18	18	16	8
M	999	41	36	36	32	5	14	6	9	9	9	8	4	2	7	17	15	9	4
A	12	24	24	33	24	7	9	4	7	7	7	5	1	2	11	8	17	17	999
M	5	18	20	22	15	12	10	1	4	6	6	3	5	8	23	38	29	999	999
J	4	2	9	9	12	16	7	5	7	8	8	2	10	7	24	46	54	999	999
J	10	13	14	12	9	16	11	8	7	9	9	4	9	12	19	23	33	999	999
A	3	6	4	3	9	15	9	8	9	11	12	8	6	12	15	13	15	999	999
S	7	7	9	10	6	9	5	6	7	10	12	9	4	9	17	47	57	17	999
O	999	25	27	18	8	10	6	5	8	10	11	9	5	13	24	54	86	65	20
N	999	999	67	47	18	9	10	4	7	8	7	4	1	7	12	24	54	70	30
D	999	999	49	41	37	10	12	7	8	9	9	4	0	1	11	11	4	9	6
1985:																			
J	999	999	27	23	26	5	0	2	5	6	5	4	3	3	7	15	9	1	1
F	999	999	16	19	23	4	7	2	4	5	6	5	3	3	9	15	9	15	9
M	999	45	54	40	30	9	10	0	6	6	6	4	2	1	10	10	22	25	18
A	6	28	39	36	12	9	14	5	4	4	4	4	5	5	5	5	9	15	999

Table 3. (continued)

M	8	22	23	16	8	14	11	5	4	3	2	3	5	6	2	2	15	999	999
J	9	6	6	10	17	12	10	6	7	7	6	6	6	9	6	13	26	999	999
J	7	9	14	8	6	16	9	9	8	8	8	8	4	8	8	14	8	999	999
A	9	11	11	11	9	13	9	8	7	9	11	9	4	10	13	23	18	999	999
S	4	6	9	10	10	11	7	7	7	10	12	11	2	11	14	19	39	17	999
O	999	34	38	25	11	10	8	6	6	7	9	9	5	16	15	28	60	47	12
N	999	999	43	31	17	11	12	3	6	6	7	4	2	10	14	28	65	72	30
D	999	999	52	48	24	10	12	6	6	6	6	3	1	7	6	2	14	18	7
1986:																			
J	999	999	71	49	34	10	15	8	7	7	7	6	2	2	8	15	8	2	5
F	999	999	73	41	32	16	11	8	6	6	7	7	4	2	7	18	14	4	6
M	999	70	61	37	33	17	12	10	7	6	6	5	1	4	10	15	9	17	4
A	6	10	20	25	18	10	10	3	7	6	5	4	3	2	4	8	18	26	999
M	4	7	15	13	8	17	11	1	6	6	6	5	7	4	17	32	29	999	999
J	1	4	9	12	8	14	8	4	6	5	6	4	9	9	6	9	17	999	999
J	7	17	13	10	11	14	10	9	9	9	9	3	4	12	10	10	10	999	999
A	7	14	12	7	8	13	10	10	10	11	11	10	3	12	12	18	18	999	999
S	11	21	9	2	5	8	7	8	9	11	13	9	0	21	26	48	64	26	999
O	999	4	3	10	17	1	7	6	8	9	9	6	1	11	14	23	31	19	5
N	999	999	22	27	15	14	10	6	8	9	9	6	4	13	20	35	64	65	24
D	999	999	61	49	33	14	13	4	8	8	8	6	2	8	6	13	10	20	12
1987:																			
J	999	999	87	70	38	5	17	6	8	9	9	7	2	0	8	11	7	6	1
F	999	999	24	35	29	6	11	7	9	9	8	8	3	3	5	20	21	17	12
M	999	8	13	47	42	8	10	1	8	8	8	7	4	8	5	22	12	15	7
A	5	12	26	41	21	14	11	2	8	8	8	5	1	3	4	7	6	7	999
M	1	3	16	20	8	21	17	6	7	7	7	4	5	6	6	11	17	999	999
J	6	14	8	12	5	13	10	5	9	9	8	3	3	6	8	10	17	999	999
J	7	9	11	7	11	14	9	7	10	12	11	8	2	11	15	2	1	999	999
A	2	6	9	5	4	11	7	8	10	13	14	7	4	13	18	11	16	999	999
S	13	25	4	11	6	10	4	6	9	11	13	12	6	11	10	25	21	5	999
O	999	15	23	19	9	1	2	5	8	10	12	10	9	11	19	41	55	22	6
N	999	999	75	48	22	9	15	7	9	10	10	6	3	6	13	27	35	24	7
D	999	999	40	41	17	13	11	5	7	9	8	5	1	2	5	14	22	21	10
1988:																			
J	999	999	19	38	35	13	11	5	6	6	6	6	1	2	8	14	10	2	2
F	999	999	38	48	40	12	13	8	6	6	7	6	3	4	6	18	14	21	13
M	999	25	29	35	36	1	8	4	6	7	7	6	1	3	9	12	13	16	10
A	28	44	33	33	17	9	8	0	5	5	6	4	3	6	6	5	13	16	999
M	3	6	4	20	11	19	11	3	4	5	5	1	6	2	8	8	8	999	999
J	4	5	1	14	10	17	7	4	4	4	5	4	5	6	10	6	7	999	999
J	3	5	19	13	6	14	10	7	7	7	7	2	5	11	30	43	26	999	999
A	10	9	9	11	6	11	7	5	6	6	8	2	5	15	36	69	64	999	999
S	3	8	9	10	4	9	5	6	7	8	10	6	1	7	43	94	110	55	999
O	999	28	31	23	9	11	9	4	7	9	11	5	2	8	31	75	114	79	22
N	999	999	57	47	23	12	11	4	6	7	6	6	2	6	9	18	45	41	13
D	999	999	21	25	29	12	13	5	7	7	6	4	2	1	4	10	11	7	4
1989:																			
J	999	999	78	59	28	10	10	8	7	7	8	6	3	3	7	15	5	12	8
F	999	999	26	30	33	15	11	7	6	7	8	7	3	3	7	13	14	8	6
M	999	19	34	11	18	8	7	7	7	7	8	6	3	1	5	2	10	17	11
A	12	29	17	10	9	3	9	4	6	6	5	3	2	3	4	8	10	15	999
M	7	8	3	20	14	15	14	4	5	6	6	2	7	3	13	25	25	999	999
J	5	10	5	13	9	16	9	4	6	7	7	2	6	10	14	17	20	999	999
J	3	6	12	9	9	13	9	8	8	9	9	4	3	13	18	10	9	999	999
A	5	9	12	7	5	11	8	8	8	9	9	6	4	16	10	3	8	999	999
S	3	3	2	13	5	9	6	6	9	11	13	9	5	5	20	41	15	3	999
O	999	66	50	20	5	11	8	5	7	10	12	7	1	12	36	62	51	49	11
N	999	999	75	43	13	15	7	2	6	6	6	3	6	14	12	33	62	42	11
D	999	999	41	21	11	16	4	4	4	5	6	3	3	6	6	13	14	7	2
1990:																			
J	999	999	83	61	41	9	11	6	4	7	8	6	3	0	6	16	14	7	2
F	999	999	88	49	23	14	2	1	4	4	4	4	6	6	8	6	11	7	
M	999	49	29	21	28	9	8	2	6	7	7	6	3	3	4	10	9	12	0
A	1	15	14	1	5	10	11	6	6	7	8	5	4	2	8	13	13	17	999
M	10	15	13	14	12	14	9	4	9	8	8	4	5	3	9	21	28	999	999
J	5	13	8	6	11	11	8	5	9	10	8	10	5	7	11	21	25	999	999
J	6	12	14	11	7	12	7	8	11	11	10	7	4	10	15	10	12	999	999
A	10	8	6	6	4	15	8	7	9	10	11	7	4	11	16	19	9	999	999
S	14	26	10	15	6	11	6	7	10	12	14	12	5	19	28	57	87	32	999
O	999	31	27	20	12	5	5	6	8	11	12	10	4	12	15	20	24	5	1
N	999	999	36	37	26	4	10	3	7	8	9	10	2	7	16	21	40	33	9
D	999	999	52	46	29	9	12	5	5	6	6	5	1	2	9	21	31	31	13
1991:																			
J	999	999	10	3	18	14	11	9	6	6	6	6	2	2	6	16	11	8	7
F	999	999	51	38	36	21	17	11	8	8	8	8	4	2	8	14	12	17	5
M	999	71	54	45	17	8	4	8	9	9	9	10	6	4	5	13	8	12	9
A	20	24	13	25	15	14	11	4	9	8	8	6	4	6	6	20	29	32	999
M	12	17	6	21	14	9	15	5	5	5	5	5	3	4	9	13	24	999	999
J	1	5	7	6	9	15	10	6	10	9	7	5	7	6	7	10	6	999	999
J	8	17	14	12	9	13	8	8	11	10	9	4	5	9	8	14	6	999	999
A	7	19	19	7	10	14	7	7	10	11	10	8	4	11	31	45	20	999	999
S	7	7	7	20	7	12	6	6	9	12	12	10	2	17	36	74	80	31	999
O	999	17	26	16	8	9	5	4	10	13	15	14	4	10	31	78	96	46	10
N	999	999	38	45	28	8	10	3	8	10	12	8	1	9	18	29	58	65	27
D	999	999	60	58	34	7	8	4	6	9	9	6	4	5	7	17	11	6	3
1992:																			
J	999	999	79	74	39	9	15	4	4	7	7	5	1	3	6	13	10	12	9

Table 3. (continued)

ZONAL WAVE-1 PHASE(DEG)

LATITUDE

	85N	75N	65N	55N	45N	35N	25N	15N	5N	EQU	5S	15S	25S	35S	45S	55S	65S	75S	85S
1978:																			
N	999	999	-35	-17	-46	-143	133	155	179	162	161	-176	-25	-12	-56	-81	-27	32	41
D	999	999	11	-11	-39	-67	115	75	-170	-176	172	-170	-59	-20	-150	-160	-165	29	50
1979:																			
J	999	999	-6	-25	-36	-86	128	63	-166	-168	-170	-149	157	-176	-134	-84	-42	1	16
F	999	999	25	16	4	-39	31	123	172	164	159	140	78	24	-164	-131	-80	-57	-50
M	999	-69	-67	-49	-40	112	112	128	170	166	164	156	148	79	-161	-74	-20	-15	-11
A	-75	-13	-80	-95	16	105	46	4	-162	-169	-174	-156	-78	33	-78	-110	-84	-39	999
M	-119	-96	-66	11	-7	124	78	-54	-160	-161	-157	-56	30	-69	-45	-81	-26	999	999
J	101	68	68	13	3	84	56	-12	-177	165	161	30	65	33	-25	-27	-8	999	999
J	55	83	133	140	67	88	101	141	174	164	164	141	123	37	2	1	7	999	999
A	147	158	155	149	109	99	101	144	169	170	172	-162	-173	-7	-39	-76	-52	999	999
S	103	32	40	0	-43	141	109	147	156	156	165	-165	-21	-24	-63	-73	-43	-24	999
O	999	8	0	-7	-86	149	159	-167	-172	177	176	-152	-54	-59	-103	-101	-79	-42	-37
N	999	999	36	14	-10	-62	116	162	170	162	165	-163	-61	3	-75	-123	-28	10	-1
D	999	999	125	94	-57	-94	152	-177	176	171	166	-169	-39	27	-159	-134	-134	-172	-165
1980:																			
J	999	999	-15	-28	-51	-79	113	127	172	172	163	154	151	-47	-108	-155	-136	-140	-155
F	999	999	-1	-7	-16	-25	162	-149	-160	-174	175	174	-169	-143	-96	-136	-101	-72	-75
M	999	4	-2	-21	-35	157	97	-19	-162	-176	172	164	-170	-15	-113	-120	-98	-62	-49
A	86	39	-32	-33	-22	105	64	-61	-141	-148	-150	-158	-118	10	130	-148	-118	-84	999
M	-166	-66	-62	-21	53	94	40	-91	-144	-164	-155	-118	4	-44	-58	-71	-57	999	999
J	-137	-76	152	80	41	85	77	159	171	160	152	133	-162	-13	-5	-96	-48	999	999
J	139	122	136	124	53	76	89	132	162	157	147	176	120	25	-4	-38	-6	999	999
A	112	104	147	128	106	94	100	121	145	138	132	157	156	7	-22	-33	-9	999	999
S	-22	21	85	0	-51	119	126	144	155	150	156	179	137	30	-66	-81	-20	23	999
O	999	0	-1	-17	-61	144	102	168	173	159	166	-159	-78	-43	-72	-78	-32	-23	-32
N	999	999	43	18	-21	-141	117	155	175	165	170	-160	-28	-35	-91	-90	-68	-45	-34
D	999	999	-18	-27	-44	-113	143	142	175	169	169	180	-29	0	-163	-135	-116	-71	-11
1981:																			
J	999	999	8	-17	-36	-84	153	142	171	162	159	162	88	99	-163	-102	-54	-22	-114
F	999	999	-35	-41	-47	-167	143	140	175	174	173	151	147	174	-146	-89	-57	-52	-106
M	999	122	70	-9	-25	-79	86	168	-139	-153	-159	-145	-106	-45	156	-121	-43	-24	50
A	103	86	36	7	-19	95	34	13	-151	-166	-167	-159	17	117	-117	-53	-33	-5	999
M	3	-42	-99	48	45	100	59	-50	-144	-156	-159	-78	-37	-82	156	125	20	999	999
J	-169	157	106	42	0	127	109	151	-170	-178	171	-28	58	-7	-72	-94	-57	999	999
J	29	50	110	115	99	87	82	133	164	154	154	171	136	-30	-28	-62	-15	999	999
A	61	83	118	160	147	106	107	131	159	154	154	160	128	-11	-41	-60	7	999	999
S	-4	15	4	-20	-32	110	102	129	137	138	147	179	-171	-25	-74	-87	-75	-79	999
O	999	-25	-14	-29	-55	96	120	156	155	148	156	-159	-55	-88	-96	-93	-73	-64	-63
N	999	999	21	-2	-31	-155	134	146	168	156	155	-166	-25	-50	-81	-72	-40	-31	-38
D	999	999	57	38	-13	-110	131	129	174	168	160	174	-174	146	-152	-142	-123	-44	-59
1982:																			
J	999	999	-3	-11	-33	-121	115	107	169	164	158	150	-159	78	-142	-98	-76	-66	-39
F	999	999	-14	-76	-66	-97	156	127	178	177	167	149	159	-138	-117	-87	-62	-96	-105
M	999	4	-3	-39	-44	177	122	91	-171	176	166	179	-164	-126	178	-95	-11	-9	-17
A	-23	15	34	33	38	90	47	3	-143	-158	-165	-127	-71	30	-14	-33	-12	20	999
M	-73	-6	33	0	12	55	46	-62	-147	-165	-162	-148	-174	-58	14	17	20	999	999
J	-99	-69	144	63	51	75	58	-171	-167	178	165	169	104	22	15	-1	-25	999	999
J	-172	125	101	36	12	90	107	157	170	162	158	-171	84	33	42	-84	98	999	999
A	155	148	179	147	122	79	92	143	147	155	160	-172	71	29	25	-22	-4	999	999
S	-161	-150	-155	-48	-61	132	124	161	158	173	174	-161	-78	-9	-35	-61	-39	-32	999
O	999	30	9	-16	-47	177	72	-160	167	173	169	-161	-58	-7	-9	-10	9	23	24
N	999	999	31	10	-28	-123	162	176	-169	-176	176	-161	-76	98	-124	-84	-58	-62	-59
D	999	999	23	7	-16	-122	134	107	-174	176	163	-147	-32	-9	-139	-144	-144	-35	-23
1983:																			
J	999	999	10	-9	-27	-99	167	151	-172	-176	178	-159	-125	12	-100	-133	-136	-148	-118
F	999	999	-10	-22	-33	-96	154	94	-150	-155	-156	-167	-118	-24	-122	-125	-141	-133	-97
M	999	45	26	-22	-21	-87	144	108	-146	-158	-174	-142	-123	-23	-171	-64	2	0	43
A	-114	-26	-23	-26	-12	116	62	-26	-120	-123	-137	-117	-19	-21	178	-81	-37	-3	999
M	74	34	19	-9	21	65	31	-41	-129	-155	-152	-64	73	123	4	-29	8	999	999
J	-149	-35	83	-16	-16	106	88	-109	-147	-161	-165	-54	45	27	18	-120	-63	999	999
J	-118	108	89	2	-6	89	103	150	166	165	162	-138	22	-13	-35	-47	-1	999	999
A	108	157	152	124	124	92	103	132	159	155	151	-173	64	-2	-74	-87	-41	999	999
S	129	118	129	14	-84	106	112	134	151	150	156	-161	-43	128	-115	-125	-117	-15	999
O	999	23	17	-6	-39	134	112	153	159	153	159	-153	-39	-15	-39	-45	-10	-5	-2
N	999	999	39	12	-24	-138	127	161	178	168	167	-178	15	-46	-56	-34	-5	9	7
D	999	999	21	11	-18	-94	120	125	167	159	154	173	-92	-19	-126	-138	-143	175	134
1984:																			
J	999	999	4	-23	-51	-89	158	119	148	145	144	143	113	-9	-145	-154	-165	161	35
F	999	999	34	9	-31	-116	138	112	155	150	145	142	143	20	175	-149	-114	-66	-20
M	999	-4	1	-22	-35	164	126	142	168	169	160	160	-153	-64	176	-136	-70	-47	-61
A	-62	-29	-55	-34	-19	111	78	52	163	159	159	179	-90	26	-137	-108	-23	-6	999
M	-11	4	16	11	-8	142	79	1	174	171	174	-149	16	-120	-128	-111	-79	999	999
J	147	64	109	22	29	88	84	167	-178	172	174	-67	40	5	-49	-39	-27	999	999
J	72	84	117	81	76	86	104	140	162	161	164	133	23	9	8	0	3	999	999
A	105	49	-153	-155	119	101	107	140	159	158	163	159	84	30	-80	-85	-56	999	999
S	175	155	97	14	-37	124	120	155	150	151	162	-172	-21	-3	-56	-65	-47	-23	999
O	999	-38	-50	-47	-65	133	118	174	179	168	168	-169	-85	-37	-38	-48	-29	-7	-1
N	999	999	43	17	-15	164	143	177	176	166	162	-179	-22	-41	-62	-40	-10	0	5
D	999	999	10	-12	-51	-120	111	127	176	173	162	179	119	-161	-141	-141	-138	-20	-54
1985:																			
J	999	999	-36	-49	-43	-77	70	-179	-170	180	172	-175	-100	-52	-138	-156	-173	-151	-119
F	999	999	2	-79	-101	-37	105	95	155	155	161	117	96	76	-171	-140	-64	-18	-3
M	999	7	11	-12	-52	-179	108	128	-154	-158	-163	-166	-150	-92	-178	-98	-14	-1	-18
A	-35	-34	-23	-13	14	109	83	59	-169	-177	-166	-178	-131	-74	-151	155	73	42	999

Table 3. (continued)

M	-29	-39	-30	-23	-20	113	46	-25	-164	-172	-158	99	137	-91	23	93	-45	999	999
J	155	102	77	-3	0	88	96	146	-161	-179	154	125	98	39	-9	-25	11	999	999
J	117	86	150	130	56	85	98	142	165	161	147	170	139	12	-43	-95	-71	999	999
A	80	93	94	95	104	92	94	134	152	144	144	173	139	-21	-65	-99	-48	999	999
S	0	60	74	-24	-32	100	113	141	149	136	143	166	142	-6	7	8	21	34	999
O	999	23	24	5	-74	144	105	153	172	157	164	-148	-16	8	4	-17	4	20	31
N	999	999	7	-12	-48	-170	115	116	172	167	163	175	6	-37	-37	-24	4	20	23
D	999	999	-27	-36	-43	-162	153	130	170	165	158	158	161	-47	-58	126	64	55	65
1986:																			
J	999	999	11	-14	-34	-124	148	125	162	162	161	154	148	-96	-169	-173	-157	38	61
F	999	999	-8	-16	-44	-70	143	120	-177	175	165	169	-169	-76	-162	-178	-173	174	-135
M	999	34	36	15	-31	-78	146	127	142	140	139	141	-159	-28	-161	-128	-76	-19	-13
A	178	-37	-19	-26	-42	99	74	74	-167	-174	179	-151	-83	-142	-107	-53	-17	5	999
M	70	-37	-56	-29	18	116	78	-58	-157	-162	-152	-110	-20	-49	-149	-127	-105	999	999
J	65	47	106	36	-19	99	82	163	-161	-178	170	-65	2	4	20	-22	-14	999	999
J	84	104	121	96	47	91	103	142	180	174	167	-143	63	-6	-18	-73	-39	999	999
A	80	80	119	141	117	93	111	138	167	168	171	174	67	2	-36	-45	25	999	999
S	-9	-5	-63	-39	31	92	125	151	155	158	164	-169	86	10	-7	-30	-12	12	999
O	999	93	100	-20	-40	-22	138	170	172	169	174	-138	-63	-14	-26	-49	-8	40	54
N	999	999	20	13	-42	-176	131	163	-179	172	162	-177	-24	-21	-22	-26	-8	9	14
D	999	999	-18	-24	-36	-129	147	169	-170	-179	171	174	-120	-40	-67	-114	-37	12	8
1987:																			
J	999	999	5	-8	-18	-142	149	130	176	172	166	175	-166	-102	-161	179	138	48	-32
F	999	999	24	13	-15	-89	170	163	-167	-166	-175	180	-173	20	-97	-126	-102	-59	-52
M	999	25	-48	-60	-59	141	106	-168	-154	-153	-163	-162	-125	-21	-95	-128	-103	8	5
A	-53	-17	-35	-44	-39	91	66	-49	-155	-160	-165	-159	-113	-17	-120	-118	-65	-79	999
M	-35	74	27	-20	-60	94	54	-75	-128	-147	-158	-129	88	22	4	18	14	999	999
J	-147	-61	-44	12	-12	84	61	-179	-164	-168	-166	-132	87	12	-18	-56	-23	999	999
J	-161	134	134	1	5	103	119	156	176	176	174	-166	-107	20	33	-130	-60	999	999
A	159	118	139	124	36	85	109	147	147	154	158	-169	-12	46	60	13	20	999	999
S	80	53	8	-81	-162	105	125	157	150	155	158	-170	-105	22	-28	-59	-7	-13	999
O	999	46	36	0	-45	-171	79	-171	170	162	169	-166	-76	-17	-45	-47	-21	-4	-21
N	999	999	20	-8	-34	150	123	118	172	160	158	-174	-53	-6	-91	-99	-71	-53	-53
D	999	999	4	-7	-29	-169	144	106	176	165	159	171	29	-49	-90	-76	-46	-29	-46
1988:																			
J	999	999	22	-7	-29	-89	-171	172	-174	-177	177	-176	-87	8	-152	-134	-126	-41	-9
F	999	999	-10	-24	-40	-119	175	-178	-173	-176	-172	160	-178	-26	-117	-117	-78	-41	-29
M	999	7	-5	-35	-48	0	97	119	-178	177	174	166	-74	-47	-155	-100	-22	0	-1
A	-84	-78	-51	-2	7	95	87	104	-160	-157	-142	-137	-58	176	-155	-25	2	32	999
M	-141	-82	-113	-43	-31	106	67	37	177	169	178	130	49	160	-141	-57	3	999	999
J	152	77	-94	-21	-11	111	84	-168	-153	159	155	16	69	-98	-89	-78	-31	999	999
J	142	65	120	86	20	84	84	130	165	148	140	72	46	-57	-94	-96	-66	999	999
A	100	68	127	124	136	81	101	123	139	118	118	-162	-10	-42	-83	-95	-78	999	999
S	51	19	73	37	-105	113	101	132	139	132	132	-148	132	-124	-117	-109	-88	-76	999
O	999	-1	2	-2	-44	137	115	157	166	156	160	-169	-43	-82	-82	-76	-54	-45	-50
N	999	999	29	8	-29	-144	120	125	-179	161	152	-163	-100	-81	-88	-42	-22	-7	0
D	999	999	68	2	-37	-113	143	131	172	166	164	178	166	-126	-149	-127	-100	-94	-163
1989:																			
J	999	999	22	7	-34	-130	137	98	154	155	158	140	169	-95	-161	179	-116	-46	-63
F	999	999	-114	-74	-62	-104	122	76	154	159	160	143	160	-84	-141	-139	-97	-49	23
M	999	72	106	92	-30	-68	174	110	-170	-172	175	159	176	128	155	-117	-1	18	43
A	-14	-1	-21	-63	-55	71	65	23	-176	-178	179	164	-144	147	-133	-105	-61	-13	999
M	133	84	91	-49	-36	104	72	8	-173	-173	-173	-89	46	178	-81	-62	-25	999	999
J	-8	-29	70	24	12	101	95	155	-164	-177	-178	-72	81	-13	-29	-17	0	999	999
J	87	136	135	71	34	78	97	134	164	162	160	152	34	1	26	26	38	999	999
A	-89	-92	-151	-170	106	98	109	136	148	143	151	178	76	8	22	-140	27	999	999
S	-168	119	-46	-41	-76	102	104	132	141	141	148	177	52	52	-121	-115	-77	53	999
O	999	31	27	14	-85	136	83	156	152	145	153	174	-96	-63	-72	-67	-38	-24	-25
N	999	999	33	17	-52	-155	136	-172	-173	171	171	-126	-66	-39	-29	-4	18	35	46
D	999	999	35	21	-33	-112	157	96	180	177	172	169	-90	-41	-102	-150	-96	-70	-62
1990:																			
J	999	999	12	-9	-33	-95	110	80	158	162	151	128	109	132	-164	-153	-129	-105	-26
F	999	999	62	58	-4	-50	-155	-170	-134	-143	-154	-167	-128	-101	-143	-131	-60	-33	-87
M	999	56	89	6	-17	-40	105	115	-158	-161	-173	178	163	-153	-147	-55	-12	1	90
A	51	94	116	26	-43	89	67	-5	-140	-160	-159	-128	-62	-101	-130	-91	-37	-5	999
M	-80	-52	11	44	46	81	55	-97	-150	-159	-156	-114	38	3	-117	-98	-76	999	999
J	-12	10	114	76	7	84	81	151	-177	180	170	138	118	1	-33	-48	-11	999	999
J	111	114	135	116	62	79	97	147	173	171	163	164	109	-16	-8	12	7	999	999
A	-141	-128	174	-117	118	99	101	137	159	152	150	171	156	-11	-48	-81	-16	999	999
S	91	78	40	-58	-72	100	110	146	149	146	153	-170	-69	-14	-15	-29	-8	-9	999
O	999	109	81	35	-48	-165	121	158	150	143	152	-177	-71	-35	-65	-61	-51	-32	88
N	999	999	-11	-28	-46	-93	107	145	175	164	167	176	-54	-61	-86	-75	-52	-39	-36
D	999	999	28	16	-29	-87	136	102	176	165	171	-175	-58	-77	-118	-89	-58	-45	-45
1991:																			
J	999	999	18	-153	-73	-97	170	157	168	166	165	161	121	36	-127	-114	-92	-75	-78
F	999	999	-1	-28	-62	-126	152	170	179	172	172	161	143	163	-141	-111	-105	-72	-53
M	999	24	13	-17	-11	103	125	177	-157	-163	-170	-178	-148	-36	-101	-120	-95	-1	-13
A	-82	-69	33	10	-4	150	79	11	-168	-171	-173	-166	-65	18	-171	-109	-64	-33	999
M	-107	-74	-45	-14	-51	103	54	-21	-158	-151	-142	-103	-3	32	-5	-45	-30	999	999
J	-34	-23	165	57	-4	86	75	-155	-138	-139	-152	-105	0	0	-92	-110	-85	999	999
J	149	130	121	85	29	79	91	150	177	178	171	179	124	-6	-51	-140	-123	999	999
A	143	145	162	166	103	95	109	153	167	173	170	179	95	-9	-60	-80	-50	999	999
S	54	35	-8	-23	-35	113	119	165	167	173	173	-137	115	-25	-62	-68	-43	-38	999
O	999	18	16	6	-64	136	43	-160	172	171	171	-146	-55	-45	-78	-79	-63	-45	-38
N	999	999	13	-5	-36	-155	117	165	-170	-173	-177	-178	-21	-57	-41	-22	-6	-6	-2
D	999	999	5	-8	-35	-114	121	70	-163	-161	-169	-178	-47	1	161	-167	-151	-105	-131
1992:																			
J	999	999	-4	-7	-18	-145	138	82	-155	-154	-170	175	-141	-54	-103	-130	-104	-60	-61

Table 3. (continued)

ZONAL WAVE-2 AMPLITUDE(DU)

LATITUDE

	85N	75N	65N	55N	45N	35N	25N	15N	5N	EQU	5S	15S	25S	35S	45S	55S	65S	75S	85S
1978:																			
N	999	999	3	10	7	8	5	3	2	3	3	3	4	2	3	6	5	9	3
D	999	999	10	26	27	4	8	5	3	4	4	3	2	3	2	6	5	6	2
1979:																			
J	999	999	5	17	12	4	7	5	2	2	2	1	3	1	4	4	2	3	3
F	999	999	25	16	13	5	8	4	2	2	3	2	2	1	3	3	3	8	5
M	999	24	23	21	20	2	8	3	3	3	2	2	2	2	4	1	4	4	1
A	2	10	14	6	18	13	8	3	2	3	2	1	1	3	4	3	1	2	999
M	0	5	13	18	21	12	3	0	2	3	4	3	1	3	5	4	2	999	999
J	1	4	13	6	13	16	5	1	2	4	4	0	3	2	14	15	10	999	999
J	1	7	16	11	11	11	4	1	3	3	3	0	5	4	8	4	7	999	999
A	1	3	16	14	6	9	4	2	2	4	4	2	1	8	8	9	5	999	999
S	4	9	12	15	6	6	4	2	2	4	5	4	2	6	12	15	12	12	999
O	999	8	7	12	4	3	0	1	1	2	2	3	5	2	9	8	6	6	1
N	999	999	23	17	7	4	4	2	2	2	1	3	3	3	1	4	13	12	2
D	999	999	6	14	8	6	2	3	2	2	2	2	4	5	1	8	7	6	5
1980:																			
J	999	999	11	21	18	7	4	4	4	3	3	3	3	4	2	3	4	9	4
F	999	999	33	37	28	3	2	2	2	2	2	2	3	3	2	8	3	5	4
M	999	25	32	22	12	8	6	2	3	3	2	1	2	4	6	9	4	8	4
A	5	12	21	27	19	8	2	2	1	2	2	0	1	1	3	7	9	7	999
M	3	13	16	27	20	10	6	0	2	1	2	2	2	4	6	8	5	999	999
J	4	15	15	7	7	14	7	2	3	5	5	3	2	5	3	4	6	999	999
J	2	6	3	4	17	11	2	1	2	3	3	1	4	10	2	5	5	999	999
A	2	9	11	7	8	8	3	0	2	3	3	2	1	3	2	2	10	999	999
S	2	2	7	14	8	8	3	0	0	2	3	2	1	4	4	3	14	8	999
O	999	19	24	18	6	2	3	1	2	3	4	5	2	4	4	8	4	8	2
N	999	999	2	11	14	1	4	2	3	3	4	2	2	3	8	10	12	8	2
D	999	999	8	29	31	14	4	4	4	5	4	3	3	4	2	3	2	1	2
1981:																			
J	999	999	7	13	9	10	3	5	4	4	3	1	3	1	4	5	6	0	1
F	999	999	25	32	15	11	1	3	4	4	4	1	3	2	2	3	6	9	5
M	999	8	19	32	23	9	7	4	1	2	2	2	0	4	4	10	8	5	4
A	0	10	21	11	15	15	5	3	1	2	2	0	3	2	4	7	3	4	999
M	2	17	27	11	21	13	2	2	1	3	3	0	3	2	3	4	6	999	999
J	2	6	1	3	19	15	2	3	3	4	5	3	7	10	5	5	12	999	999
J	1	4	5	5	10	12	3	0	1	3	4	1	1	6	8	4	3	999	999
A	1	1	8	6	2	10	2	1	1	2	3	4	1	13	18	14	6	999	999
S	1	2	7	12	8	4	3	1	1	2	3	3	3	9	11	13	17	7	999
O	999	19	24	19	18	1	5	2	1	1	2	0	2	4	5	9	7	6	2
N	999	999	13	13	11	2	5	3	3	3	3	4	4	3	4	3	7	11	2
D	999	999	23	28	15	5	5	3	4	4	3	3	5	4	4	4	4	6	2
1982:																			
J	999	999	28	37	28	6	6	2	4	4	3	2	2	2	2	3	2	3	3
F	999	999	14	27	16	13	10	1	3	3	2	2	3	2	2	6	5	4	3
M	999	6	18	24	7	10	12	2	3	3	2	3	3	0	3	7	4	2	1
A	2	8	16	13	12	11	6	2	2	3	3	3	1	1	6	6	3	5	999
M	2	6	12	19	22	10	3	1	1	2	2	2	5	4	1	5	7	999	999
J	2	4	6	18	14	8	5	0	2	3	3	2	1	9	2	6	8	999	999
J	3	2	10	7	14	10	1	1	1	3	3	1	3	5	4	3	4	999	999
A	1	2	5	3	6	9	1	3	1	1	2	3	1	8	7	0	4	999	999
S	2	13	12	18	4	6	1	2	2	1	2	3	5	4	2	4	7	3	999
O	999	8	8	16	7	5	2	2	2	3	4	3	1	6	6	7	8	20	3
N	999	999	7	14	3	7	5	1	3	6	7	4	4	3	4	6	13	16	1
D	999	999	11	13	6	12	7	5	3	4	5	7	2	2	6	2	1	3	1
1983:																			
J	999	999	15	18	9	4	2	1	2	3	4	4	1	3	8	1	7	5	2
F	999	999	26	15	14	3	6	5	1	1	2	3	2	4	2	6	9	3	1
M	999	26	33	13	5	7	4	2	1	1	0	3	1	3	3	7	5	3	1
A	7	20	14	20	2	7	5	4	1	1	1	2	2	11	7	5	7	6	999
M	5	14	22	13	11	7	6	3	1	3	3	2	1	4	2	1	9	999	999
J	1	3	11	10	14	11	3	2	1	2	3	4	5	6	5	5	5	999	999
J	1	9	14	5	12	12	4	2	2	3	4	2	6	6	2	6	4	999	999
A	3	2	9	2	13	10	2	0	1	3	3	1	2	8	8	11	2	999	999
S	2	1	8	4	6	7	4	2	1	2	4	2	4	2	5	5	13	8	999
O	999	6	5	12	12	5	3	2	1	2	4	4	5	2	3	7	5	13	2
N	999	999	5	3	6	2	2	3	3	3	3	3	3	4	3	9	4	6	3
D	999	999	11	19	11	3	0	2	4	4	3	2	1	3	3	2	5	4	1
1984:																			
J	999	999	12	23	17	1	7	2	4	4	3	2	2	3	3	5	10	4	0
F	999	999	20	22	10	1	3	4	4	4	3	1	2	4	1	8	5	7	3
M	999	27	28	23	24	17	4	5	4	4	2	2	2	2	1	6	1	6	5
A	6	23	24	10	10	5	6	6	4	4	3	2	2	2	2	2	4	8	999
M	1	15	12	6	21	18	5	3	4	6	6	4	5	5	11	9	13	999	999
J	3	4	7	12	19	16	4	3	3	5	5	1	1	2	6	6	8	999	999
J	2	5	5	5	13	11	3	1	3	4	5	2	3	9	5	5	9	999	999
A	3	7	10	3	12	10	1	0	2	4	5	3	2	9	10	3	2	999	999
S	4	2	5	7	5	6	2	2	3	4	5	2	2	7	6	10	14	3	999
O	999	15	22	17	8	3	3	2	3	2	2	1	5	6	5	15	19	14	4
N	999	999	11	17	10	5	4	3	2	1	1	2	2	3	3	11	13	11	2
D	999	999	32	34	13	13	8	3	4	4	3	3	4	4	3	9	6	6	2
1985:																			
J	999	999	37	48	36	3	6	5	3	3	2	2	2	2	2	8	6	1	1
F	999	999	25	25	26	3	7	1	2	2	2	0	0	2	2	7	2	4	2
M	999	10	21	20	15	11	8	2	2	2	2	1	1	1	3	8	6	6	3
A	7	20	4	14	20	10	7	4	0	2	2	1	2	3	9	7	4	6	999

Table 3. (continued)

M	2	6	12	19	17	13	6	2	2	3	4	3	2	6	7	3	3	999	999
J	2	3	5	11	16	11	3	2	2	3	4	3	3	5	3	7	10	999	999
J	2	6	9	5	12	11	3	1	1	3	3	2	1	3	5	1	3	999	999
A	2	1	6	13	3	7	3	1	1	2	4	2	3	8	7	4	4	999	999
S	3	15	14	17	8	7	3	0	0	2	4	2	1	6	3	7	12	6	999
O	999	7	3	10	9	5	4	1	2	3	4	5	3	2	0	8	5	8	2
N	999	999	17	25	23	2	4	3	2	3	3	3	3	2	2	12	5	1	1
D	999	999	42	51	30	2	5	4	4	4	4	2	3	1	3	3	6	5	2
1986:																			
J	999	999	14	18	12	1	3	2	3	3	4	2	3	1	1	6	5	7	2
F	999	999	18	13	21	9	3	3	4	4	4	2	3	1	6	8	9	6	3
M	999	11	34	38	10	6	5	4	3	3	2	1	1	1	4	6	1	5	2
A	2	9	4	19	27	17	3	5	2	3	3	1	1	3	2	3	5	9	999
M	1	3	10	16	19	13	6	0	1	2	3	1	2	4	6	14	12	999	999
J	3	13	17	7	16	13	4	1	2	3	4	1	3	2	7	5	6	999	999
J	1	5	5	6	14	11	1	1	2	3	4	2	3	7	8	6	5	999	999
A	1	2	2	5	6	7	1	2	1	3	4	4	5	7	8	13	17	999	999
S	1	4	1	3	8	5	2	1	1	2	3	2	1	4	8	13	7	8	999
O	999	9	14	20	11	1	2	2	2	3	3	3	2	2	3	10	18	3	1
N	999	999	22	35	25	3	7	2	1	2	2	2	2	6	5	12	14	3	1
D	999	999	4	7	6	8	3	0	2	3	3	1	3	1	1	3	8	5	2
1987:																			
J	999	999	37	29	15	4	2	2	3	3	3	4	3	4	5	5	8	2	2
F	999	999	19	28	26	1	3	2	2	2	2	1	2	2	1	7	6	2	3
M	999	24	24	21	14	4	5	2	1	1	1	1	1	2	6	4	2	2	1
A	8	25	26	7	21	9	2	1	1	2	2	2	0	3	2	4	3	3	999
M	2	15	21	18	20	6	0	3	1	1	1	1	3	3	1	4	2	999	999
J	1	8	9	18	14	12	6	2	2	2	2	1	2	7	9	9	6	999	999
J	2	4	8	10	13	10	3	2	2	4	4	2	2	4	4	3	2	999	999
A	1	2	8	4	9	8	3	1	0	2	3	3	2	3	2	1	4	999	999
S	2	5	9	3	7	5	4	1	0	1	2	2	1	5	11	10	7	6	999
O	999	15	26	25	10	7	4	1	1	1	2	2	3	2	2	8	5	5	0
N	999	999	13	16	8	2	3	3	2	2	2	3	3	3	10	9	4	1	
D	999	999	17	18	12	4	4	2	3	4	4	3	3	2	3	6	9	3	2
1988:																			
J	999	999	32	34	11	7	5	5	3	4	4	2	2	1	3	6	4	5	2
F	999	999	30	50	33	9	3	5	4	4	3	1	2	2	2	6	6	5	2
M	999	10	12	9	9	4	4	3	2	3	2	1	1	0	2	2	5	4	4
A	7	11	15	21	25	11	2	3	1	3	2	1	2	3	6	1	8	5	999
M	2	10	24	14	11	10	4	2	1	4	4	1	2	2	2	10	6	999	999
J	2	5	16	10	20	11	1	2	2	3	4	2	3	5	5	2	5	999	999
J	1	4	5	13	12	8	2	1	2	3	3	3	1	4	6	9	5	999	999
A	0	4	7	4	5	7	3	1	2	3	3	2	2	8	3	4	9	999	999
S	2	6	6	9	3	6	3	2	1	2	3	4	1	8	11	6	16	8	999
O	999	6	6	17	18	1	4	3	2	2	5	5	5	4	11	21	17	14	2
N	999	999	9	1	6	4	2	3	3	4	4	4	4	4	3	12	10	2	2
D	999	999	10	21	20	4	5	3	4	4	3	3	3	5	1	11	9	5	1
1989:																			
J	999	999	15	25	15	5	7	2	2	3	3	2	2	3	3	10	7	0	0
F	999	999	29	28	5	12	9	2	3	3	3	1	1	1	2	1	2	7	4
M	999	23	40	37	13	11	5	3	4	4	2	2	2	1	0	4	3	2	1
A	3	19	38	25	18	7	6	2	2	3	2	2	1	1	4	6	2	5	999
M	2	9	20	16	15	14	5	2	3	5	5	1	2	3	1	5	4	999	999
J	1	7	14	10	14	11	2	3	3	5	5	3	1	5	3	3	4	999	999
J	0	6	10	5	9	10	2	0	2	3	4	3	2	7	2	9	10	999	999
A	3	9	18	6	3	7	2	2	2	3	4	2	3	8	5	9	8	999	999
S	1	11	22	15	4	6	3	1	1	3	3	1	1	6	5	5	7	4	999
O	999	4	8	12	8	6	3	1	1	2	3	5	2	8	11	12	14	15	3
N	999	999	7	12	12	3	4	1	1	2	3	3	2	4	10	15	12	1	2
D	999	999	1	23	25	4	6	3	2	2	2	2	3	3	4	3	9	2	2
1990:																			
J	999	999	18	33	15	7	7	2	3	2	2	2	3	1	3	4	6	5	3
F	999	999	34	46	22	9	7	3	1	1	3	3	1	2	2	11	9	1	1
M	999	5	19	18	14	5	3	1	1	1	1	1	1	1	4	3	4	2	0
A	4	8	22	9	10	10	5	2	2	1	2	1	2	3	3	4	10	7	999
M	5	18	15	7	15	14	6	1	2	3	4	3	3	6	4	5	5	999	999
J	1	7	9	11	16	14	4	2	2	4	4	3	2	4	2	2	4	999	999
J	4	6	9	7	9	10	2	1	2	3	3	4	5	6	6	7	1	999	999
A	4	12	10	5	5	8	1	1	1	2	3	1	3	7	4	3	1	999	999
S	2	4	2	6	8	8	3	1	0	1	2	1	4	7	2	6	18	13	999
O	999	11	6	5	7	2	2	1	1	1	1	2	1	2	3	2	2	2	0
N	999	999	8	15	14	6	4	2	2	2	3	3	4	5	6	8	24	16	4
D	999	999	10	15	6	5	5	3	2	2	3	3	4	1	5	9	7	3	1
1991:																			
J	999	999	16	34	23	4	9	1	2	3	4	2	3	1	3	5	5	1	2
F	999	999	30	28	18	10	2	2	2	3	4	1	3	2	4	2	4	7	3
M	999	10	28	30	15	10	11	3	2	3	3	1	1	1	4	3	3	5	2
A	4	15	20	18	11	11	7	3	2	3	3	0	1	2	2	4	3	4	999
M	3	8	16	16	15	13	2	2	1	2	2	2	3	3	7	4	5	999	999
J	3	8	14	21	15	11	4	2	3	3	4	2	2	7	12	11	7	999	999
J	2	6	3	5	14	11	3	2	2	1	2	1	3	2	10	16	13	999	999
A	1	6	2	4	7	8	1	2	1	1	2	4	5	2	5	8	9	999	999
S	3	4	12	9	10	4	1	1	1	1	1	2	2	6	3	1	19	7	999
O	999	7	7	14	14	2	1	0	0	1	2	3	5	7	19	32	35	12	2
N	999	999	7	13	5	2	2	0	1	2	3	1	1	4	3	10	19	12	3
D	999	999	10	12	5	6	3	2	2	2	3	3	2	2	2	7	11	7	1
1992:																			
J	999	999	26	24	8	8	3	2	0	2	3	4	2	1	3	4	6	3	1

Table 3. (continued)

ZONAL WAVE-2 PHASE(DEG)

LATITUDE

	85N	75N	65N	55N	45N	35N	25N	15N	5N	EQU	5S	15S	25S	35S	45S	55S	65S	75S	85S
1978:																			
N	999	999	-94	-91	-51	33	58	6	5	0	-17	23	43	-37	85	121	139	-177	-97
D	999	999	-33	-68	-94	-65	54	23	9	18	3	22	43	0	-119	-176	-147	-65	-58
1979:																			
J	999	999	-151	-104	-77	109	68	22	57	42	0	21	88	69	-79	5	-67	-44	-29
F	999	999	-132	-109	-108	162	70	1	9	6	-18	-12	63	71	111	123	90	-1	-41
M	999	157	-140	-97	-86	-16	62	39	35	40	1	29	60	-105	174	176	21	0	84
A	34	137	167	-106	-62	-20	0	-37	32	47	31	42	-60	-121	15	74	133	-53	999
M	-108	-71	-81	-30	-40	-34	-70	69	105	82	77	145	-145	-95	-165	169	46	999	999
J	172	154	-153	9	-13	-24	-18	59	57	37	28	141	-172	47	45	21	63	999	999
J	-69	-54	-57	-26	-47	-33	-17	-17	74	59	54	88	-69	72	119	137	91	999	999
A	-129	-128	-111	-95	-29	-11	-15	-116	48	47	42	42	-121	8	-23	-81	38	999	999
S	-26	-24	-51	-78	-57	-4	-7	27	36	29	28	21	73	-8	28	41	8	37	999
O	999	51	-31	-61	-64	122	-39	72	86	48	25	48	78	-56	-50	-73	77	12	29
N	999	999	-58	-79	-171	92	12	17	42	13	-28	-53	14	143	-16	76	87	90	63
D	999	999	-30	-75	-83	108	53	113	40	0	-50	-37	15	42	-117	-172	-115	-86	-38
1980:																			
J	999	999	-67	-101	-103	17	40	121	68	47	34	45	47	34	65	166	-115	-83	-74
F	999	999	-95	-97	-100	88	74	131	100	65	61	54	50	33	-42	-125	-115	1	-34
M	999	-170	-156	-125	-113	89	50	-111	104	94	51	-23	35	78	-90	-87	26	-1	-60
A	-164	-165	-115	-65	-55	-55	2	-52	112	79	65	-88	177	80	133	57	26	9	999
M	170	166	-118	-49	-37	-8	-11	-73	119	66	60	109	-115	-20	107	113	34	999	999
J	-140	-154	-129	-52	-18	-21	-26	-41	62	48	44	94	176	-34	68	73	130	999	999
J	132	115	-88	0	-40	-28	-15	-104	57	45	25	122	-73	-43	-8	53	22	999	999
A	92	70	69	49	-41	-34	-13	90	60	44	26	89	-59	15	-80	-100	38	999	999
S	138	-161	-117	-66	-91	-3	-37	-141	31	33	21	15	-37	28	7	84	48	28	999
O	999	35	8	-33	-129	156	39	28	-12	-9	-12	20	87	-84	-24	58	-98	-49	-28
N	999	999	-2	-39	-72	-57	80	21	17	-3	-19	9	53	-49	-15	4	13	-5	0
D	999	999	-51	-93	-72	-48	89	65	41	33	13	3	40	22	-86	135	138	62	10
1981:																			
J	999	999	-52	-56	-19	25	176	90	47	37	15	34	31	29	143	165	170	12	-10
F	999	999	-118	-107	-77	1	-131	87	56	38	4	6	61	79	-133	-81	-52	-67	-40
M	999	-179	-88	-86	-91	161	89	44	125	77	39	9	23	-133	-128	164	146	-44	-85
A	-140	-165	-167	-140	-52	-17	-2	23	73	79	72	85	-61	-5	116	143	-36	-59	999
M	-142	-149	-126	-55	-6	-16	-28	-32	19	51	49	-134	-64	-46	111	-104	32	999	999
J	41	43	150	-25	-18	-31	-56	46	78	60	56	151	-122	-61	-58	59	87	999	999
J	-19	-20	-79	-73	-11	-25	-26	18	41	32	31	49	-1	-7	10	-4	117	999	999
A	-109	-105	-63	-86	-65	-17	1	123	83	49	40	132	20	0	-21	-14	18	999	999
S	84	6	-33	-41	-73	-29	24	19	97	28	13	-31	83	68	82	77	103	64	999
O	999	-18	-34	-64	-117	73	21	12	80	39	9	107	15	-57	-65	-36	-21	-14	-4
N	999	999	-42	-72	-108	112	37	29	34	29	31	43	60	-116	-69	40	-56	-26	-34
D	999	999	0	-13	-52	159	113	77	43	28	14	47	59	154	-123	-40	-33	-61	-71
1982:																			
J	999	999	-85	-107	-99	-36	33	56	70	59	50	35	42	5	71	102	153	-46	-90
F	999	999	-137	-118	-94	69	31	142	85	70	41	32	58	-158	-171	137	111	24	-62
M	999	-55	-104	-97	-91	64	7	-11	63	55	19	38	65	95	-162	-148	-33	35	38
A	-118	-19	-96	-90	-90	-33	-32	-95	87	83	78	110	90	-9	-10	-51	-161	37	999
M	-40	-123	-88	-47	-42	-27	-16	-43	52	78	91	171	-125	-18	31	-178	111	999	999
J	85	30	-55	-34	-39	-20	-25	28	78	58	57	104	-90	-42	-15	95	79	999	999
J	124	-113	-78	-36	-34	-43	-153	-154	-10	-4	22	74	-145	-57	-175	102	78	999	999
A	116	137	-87	-55	27	-11	5	177	-130	0	5	-34	6	72	116	-112	49	999	999
S	4	21	-51	-69	-113	-4	-22	-176	-58	-22	10	-49	-2	42	57	37	-53	-63	999
O	999	3	-54	-59	-65	43	10	-169	-121	-108	-111	-108	118	47	80	157	28	55	49
N	999	999	-72	-72	-61	66	-21	-9	-65	-77	-77	-60	79	117	48	42	89	120	164
D	999	999	-72	-82	175	109	27	-22	-35	-20	-39	-24	43	28	-13	62	-42	-46	-67
1983:																			
J	999	999	-95	-86	-88	131	82	4	-31	-16	-13	-30	108	79	25	-78	-149	-102	-24
F	999	999	-160	-118	-44	-84	-173	119	-58	48	11	-51	32	46	60	-68	-93	-79	-30
M	999	-158	-136	-123	18	60	-77	-153	-62	-63	-6	-17	69	169	49	37	84	31	-18
A	176	-159	-115	-61	-95	108	-25	-35	-77	19	15	31	128	-126	-50	71	46	10	999
M	151	156	-171	-122	-48	-26	-53	-82	49	44	39	99	-166	-84	-57	97	79	999	999
J	-20	-9	-83	-57	-27	-40	-1	9	96	39	48	165	-141	-71	-33	-26	68	999	999
J	-89	-69	-83	-21	-25	-32	-35	-38	18	8	20	142	-158	-71	-118	145	98	999	999
A	170	-162	-142	-156	-5	-21	-38	-170	8	8	3	-34	-53	-64	-95	-162	41	999	999
S	61	148	157	-165	-80	-29	-31	-53	-65	-17	-6	33	97	-11	-19	6	64	48	999
O	999	2	1	-53	-67	-41	-6	-7	-43	-24	-8	-10	28	168	-157	170	-39	-16	-1
N	999	999	108	35	-97	-129	89	48	5	0	0	34	33	10	143	167	175	15	-3
D	999	999	-49	-71	-99	-61	-85	44	24	19	0	-16	24	4	-52	-109	-179	154	7
1984:																			
J	999	999	-13	-77	-88	-82	106	57	10	1	-28	-51	-5	24	-93	165	160	176	-120
F	999	999	-74	-82	-99	94	70	46	15	4	-24	-62	-37	22	-116	-122	-77	-16	3
M	999	-156	-141	-112	-71	-50	170	63	31	24	4	-9	19	9	168	134	151	-14	-60
A	-175	-157	-138	-95	-49	-34	6	-6	35	52	45	77	104	-34	55	-30	18	24	999
M	-98	-99	-116	22	-10	-44	-108	38	42	55	54	67	177	-61	9	45	81	999	999
J	-31	-70	-73	0	-20	-43	-48	-8	38	33	25	61	129	-105	134	76	-4	999	999
J	47	0	-36	-16	-34	-36	-53	-1	50	40	37	81	154	-58	-54	17	58	999	999
A	147	-152	-117	-53	-6	-19	-39	25	75	49	42	57	-164	-73	-56	-123	-23	999	999
S	7	50	-132	-99	-112	-19	1	20	59	50	50	61	0	-29	-22	-54	-69	4	999
O	999	-28	-59	-70	-99	33	6	66	100	80	61	60	24	35	48	62	52	14	32
N	999	999	-65	-82	-113	136	29	13	38	-9	-81	-17	41	-128	151	129	176	-172	-144
D	999	999	-71	-101	-107	56	46	94	39	20	11	41	70	-72	-118	118	122	-33	-46
1985:																			
J	999	999	-116	-97	-92	-128	131	88	55	53	35	20	65	-35	-148	133	129	-72	-67
F	999	999	-170	-149	-120	-82	41	11	22	55	78	-137	-83	14	173	-147	-102	-13	58
M	999	-140	-106	-92	-134	56	-8	-13	31	39	2	61	136	-39	-76	-111	-64	-16	-45
A	-152	159	146	-72	-72	-21	-9	-82	58	93	89	122	37	-94	-106	-113	-76	-28	999

Table 3. (continued)

M	179	175	-135	-83	-44	-1	-11	-135	101	68	66	106	179	-63	-117	151	0	999	999
J	177	135	-43	0	-36	-39	-24	22	62	53	55	-156	-129	-20	89	63	30	999	999
J	173	-168	-123	-52	-28	-23	-18	-162	131	46	51	142	-112	33	94	68	112	999	999
A	69	7	-96	-66	-35	-6	-8	123	85	37	23	82	-128	-62	-47	161	-112	999	999
S	11	22	4	-58	-78	11	-15	-18	0	14	12	23	-48	-27	60	107	-4	6	999
O	999	0	54	-115	-85	-11	-6	-63	6	16	6	16	53	-79	-155	116	-11	-9	10
N	999	999	-50	-100	-114	-138	25	-1	17	13	11	25	70	5	174	148	-175	49	55
D	999	999	-42	-67	-80	-10	96	62	45	38	30	13	97	-58	-130	-162	-108	-61	-19
1986:																			
J	999	999	-2	-39	-44	47	109	65	24	14	-5	5	49	0	153	153	-171	-97	-59
F	999	999	-167	-109	-46	-4	-160	118	50	38	7	-20	54	-70	-103	-164	144	31	0
M	999	-71	-93	-92	-75	43	23	4	42	38	14	-28	9	-12	-150	-148	-169	-33	0
A	175	159	-175	-50	-64	-47	19	71	74	66	54	54	111	-149	-65	-93	-29	25	999
M	-57	-152	-108	-38	-30	-9	12	-86	-4	54	68	123	-177	-17	42	72	67	999	999
J	-124	-155	-147	-40	-15	-30	-62	21	74	43	47	29	175	114	40	-45	-44	999	999
J	-106	-72	-18	-3	-35	-34	-9	-110	48	39	45	114	-116	-36	35	31	111	999	999
A	-125	-171	60	-12	-37	-21	-106	171	79	48	48	54	64	-25	-18	2	6	999	999
S	-58	-53	-158	-130	-97	0	-5	-176	47	39	34	56	110	37	105	127	70	21	999
O	999	21	-53	-64	-76	83	26	30	37	31	17	18	137	-59	18	80	34	-39	70
N	999	999	-44	-65	-78	13	38	2	28	12	-15	-10	82	34	109	177	179	122	26
D	999	999	-119	-45	-10	91	29	87	-6	-22	-53	-30	97	-3	-60	180	-160	-144	-148
1987:																			
J	999	999	-140	-127	-115	145	-174	48	20	3	-18	-16	51	16	-28	170	149	131	-22
F	999	999	-158	-97	-82	-154	148	100	67	49	7	-13	37	5	141	-166	171	-127	-43
M	999	-137	-119	-80	-57	60	57	3	143	84	47	-5	10	45	68	81	-155	86	114
A	124	169	-153	-95	-19	-22	11	51	89	49	44	34	145	-86	27	73	109	74	999
M	105	-170	-115	-46	-58	-28	59	-80	177	50	23	131	-149	-118	-16	114	160	999	999
J	101	168	-103	-25	-31	-13	-14	-56	67	57	53	109	-57	16	19	24	25	999	999
J	180	-103	-100	-42	-27	-18	-43	-14	39	34	48	111	180	42	55	-11	-21	999	999
A	23	144	-142	-71	-34	-21	-27	-110	-3	14	4	-19	100	-151	146	-172	-11	999	999
S	-96	-55	-34	-105	-140	16	-14	173	165	21	22	-152	100	41	46	53	93	92	999
O	999	0	-30	-56	-108	100	11	25	11	-32	-29	0	51	-31	68	102	-92	-53	-108
N	999	999	-117	-114	-121	21	9	-22	1	-24	-42	3	56	-1	-102	-122	-61	-52	37
D	999	999	-76	-77	-103	65	51	20	26	10	-2	28	66	-53	28	65	70	50	-58
1988:																			
J	999	999	-108	-84	-79	116	127	103	35	7	-25	-36	54	-160	-54	-45	-16	-19	-6
F	999	999	-102	-97	-84	-39	116	80	46	22	-17	18	97	4	76	178	-148	-97	5
M	999	-119	-135	-94	-123	156	48	11	22	39	-2	10	59	-49	-117	-11	-58	-50	-61
A	170	171	-102	-39	-64	-77	55	69	45	78	57	97	138	-85	-22	-6	9	13	999
M	167	158	-153	-65	-34	-14	-8	-23	20	54	44	105	-167	-126	114	81	54	999	999
J	51	-26	-109	-41	-17	-43	57	18	67	42	39	102	-168	-101	-137	-152	-7	999	999
J	64	65	-82	-11	-14	-36	-21	-11	56	32	15	41	-172	-132	130	135	108	999	999
A	-100	-47	-74	-8	11	-24	-50	53	47	25	20	0	-172	-106	-83	14	-15	999	999
S	-63	9	3	-49	-88	-13	0	46	64	-2	-1	-50	14	-100	-66	-22	-147	-134	999
O	999	48	-37	-60	-91	-84	35	65	78	28	20	40	90	-61	-25	36	17	-37	-11
N	999	999	84	113	-146	-12	19	52	45	28	15	25	78	-118	6	78	107	6	-21
D	999	999	-19	-46	-64	12	69	72	67	52	39	82	56	26	157	-145	-111	-110	-82
1989:																			
J	999	999	-29	-101	-114	57	38	-16	12	1	-11	-28	-20	-50	147	127	139	-162	126
F	999	999	-32	-77	-99	68	37	43	50	18	-11	26	67	30	-162	113	15	-59	-44
M	999	-137	-129	-117	-93	-9	37	79	71	59	18	-2	57	-164	-155	4	-19	19	115
A	-75	-131	-125	-119	-94	-22	12	3	56	63	61	70	-9	160	138	177	-136	-73	999
M	-61	-133	-102	-87	-55	-30	-18	-6	40	64	61	115	-83	-50	72	173	137	999	999
J	85	-128	-56	-30	-21	-30	-79	24	55	55	57	110	-171	-45	-31	117	43	999	999
J	54	-51	-70	-35	-24	-25	-9	-60	59	47	48	103	-70	-41	-68	89	100	999	999
A	-16	-84	-81	-66	23	-11	46	140	90	52	40	62	-45	-34	-131	177	39	999	999
S	-149	-55	-56	-87	-68	-3	2	49	62	31	28	4	-48	-35	-80	-176	-36	60	999
O	999	56	-48	-89	-139	26	2	32	107	27	15	23	57	-32	-2	54	-14	-25	-10
N	999	999	-60	-115	-139	152	12	3	67	33	33	76	48	95	155	-168	-166	79	33
D	999	999	-11	-113	-99	-179	101	77	107	72	43	5	62	-36	-98	79	126	174	-60
1990:																			
J	999	999	-37	-97	-70	49	64	89	65	39	23	6	50	76	-71	-42	-8	-44	-39
F	999	999	-72	-98	-140	107	33	-64	-71	-21	-20	-33	150	-118	51	71	80	-22	-33
M	999	142	-102	-101	-82	-65	27	-12	54	46	-14	3	76	141	-102	-43	12	27	117
A	75	-88	-100	-89	-37	-43	-57	-7	4	50	3	-29	96	-148	-76	-39	31	22	999
M	-140	176	172	-71	-36	-24	-20	-41	95	74	55	100	158	-108	-36	47	99	999	999
J	155	156	-123	-38	-26	-33	-43	-11	65	48	52	120	-131	5	73	132	-132	999	999
J	-167	-118	-80	-11	-15	-32	-51	-137	45	51	52	151	-136	-29	20	35	67	999	999
A	106	172	-103	-52	2	-18	-10	178	4	28	27	127	-79	-36	-34	-173	42	999	999
S	172	40	-29	-69	-29	-28	-27	165	-118	0	10	162	-35	5	88	130	-16	0	999
O	999	-114	-123	-131	-131	118	3	129	43	-27	-5	58	168	139	120	124	-115	-10	9
N	999	999	-48	-77	-77	-18	33	-16	0	-19	-31	-16	54	0	-30	-4	11	-5	0
D	999	999	-24	-91	-102	75	22	16	16	-7	-23	-23	59	-112	-43	1	64	151	-14
1991:																			
J	999	999	-91	-101	-101	81	65	-14	8	-6	-34	-31	49	43	-156	139	140	106	12
F	999	999	-125	-100	-61	10	-58	-91	54	4	-32	-12	89	110	-152	-108	-40	-39	-39
M	999	-111	-137	-120	-113	89	37	-11	91	51	3	-17	83	82	-56	-66	-69	18	30
A	-155	-121	-123	-78	-25	-16	-27	-31	75	69	39	101	-80	-117	-23	154	122	0	999
M	-127	-155	-116	-54	-14	-10	-39	-45	69	68	62	144	-138	42	63	8	-43	999	999
J	-151	-132	-66	-27	-34	-5	-9	-30	101	94	74	145	-169	27	16	-8	36	999	999
J	36	88	67	-25	-39	-14	5	-117	77	54	36	-133	-88	28	106	73	46	999	999
A	90	135	150	7	-4	-25	81	-171	123	113	39	111	157	-26	63	119	93	999	999
S	-94	18	1	-41	-62	-42	105	-161	-82	143	-9	-47	-39	-10	-46	101	-70	-45	999
O	999	-3	-52	-62	-80	-106	-18	74	-23	-121	-90	-44	50	43	28	42	61	50	40
N	999	999	-35	-35	-26	-151	-158	79	-3	-45	-55	53	104	-60	-96	-129	-96	-70	-65
D	999	999	-52	-83	-140	72	0	-11	-17	-22	-33	-4	67	101	-35	-84	-90	-86	-48
1992:																			
J	999	999	-162	-143	-127	75	90	-88	-32	-13	-38	-25	50	-23	36	130	179	-154	-58

Table 3. (continued)

ZONAL WAVE-3 AMPLITUDE(DU)

LATITUDE

	85N	75N	65N	55N	45N	35N	25N	15N	5N	EQU	5S	15S	25S	35S	45S	55S	65S	75S	85S
1978:																			
N	999	999	6	16	13	5	6	2	1	1	3	3	1	3	6	4	5	2	1
D	999	999	15	24	17	6	5	5	2	2	3	2	2	3	3	4	1	3	1
1979:																			
J	999	999	12	22	21	2	6	3	1	1	1	3	2	4	4	8	7	3	1
F	999	999	10	4	6	4	5	4	1	1	2	4	1	2	5	6	6	5	0
M	999	13	10	13	14	4	10	4	1	1	2	3	1	3	11	11	4	3	1
A	3	1	7	13	22	11	9	4	0	0	1	1	1	4	3	6	4	2	999
M	1	5	7	3	7	10	2	3	1	1	1	0	2	0	2	6	2	999	999
J	1	5	15	8	6	3	3	2	1	1	2	2	2	4	8	16	5	999	999
J	1	5	6	4	4	1	3	1	2	2	2	1	4	3	8	10	3	999	999
A	0	6	6	2	1	0	3	1	1	1	2	1	1	5	3	3	3	999	999
S	0	0	2	7	3	3	1	1	1	2	2	2	2	2	1	5	5	2	999
O	999	1	3	5	4	6	2	1	1	1	2	3	1	3	5	5	3	5	0
N	999	999	13	15	14	12	5	2	2	2	3	4	1	5	5	4	12	3	0
D	999	999	4	10	9	4	3	2	2	3	4	4	1	2	4	5	3	5	1
1980:																			
J	999	999	3	11	20	7	3	0	2	2	3	3	1	1	6	8	4	4	0
F	999	999	7	11	28	8	5	2	0	1	2	3	1	3	10	15	11	7	2
M	999	5	8	18	24	10	11	3	0	1	2	4	2	2	7	8	6	6	1
A	1	7	13	7	16	13	6	2	1	0	1	2	1	3	8	7	2	4	999
M	2	1	8	4	5	10	5	2	2	3	3	3	3	0	8	11	3	999	999
J	1	3	9	8	4	5	4	2	1	2	2	1	2	3	1	2	1	999	999
J	0	3	8	6	3	2	2	1	2	1	2	2	4	5	12	15	7	999	999
A	1	4	9	11	6	2	1	1	2	1	1	1	2	3	9	10	2	999	999
S	3	4	3	11	5	4	2	1	2	1	1	2	3	4	7	5	2	1	999
O	999	4	6	6	5	8	3	1	1	1	2	2	2	4	5	4	5	3	0
N	999	999	7	11	7	2	3	2	1	2	3	3	3	2	9	11	11	7	1
D	999	999	7	20	18	9	7	2	1	1	2	3	0	2	8	8	4	1	0
1981:																			
J	999	999	14	29	27	11	7	4	1	1	2	5	1	1	2	3	3	4	1
F	999	999	4	17	23	10	10	5	1	1	1	4	1	2	4	5	3	4	0
M	999	7	5	17	20	10	6	6	2	1	1	2	1	1	6	9	7	3	2
A	1	9	19	23	15	4	11	3	1	1	2	3	1	4	7	9	1	4	999
M	1	2	17	9	8	8	1	3	2	2	2	1	1	3	5	5	3	999	999
J	1	4	1	3	11	5	2	2	0	1	1	1	2	2	6	6	4	999	999
J	1	3	5	8	4	2	1	1	1	1	1	2	3	7	6	12	7	999	999
A	1	2	7	8	2	3	0	1	2	2	2	2	3	2	4	4	1	999	999
S	1	2	3	2	3	3	0	0	1	1	2	3	1	6	13	3	3	4	999
O	999	5	4	10	7	5	4	2	1	0	2	3	2	4	6	10	4	4	0
N	999	999	12	16	12	7	4	2	1	0	1	1	3	1	3	5	5	3	1
D	999	999	4	10	14	9	7	3	2	1	2	3	1	2	5	8	5	3	1
1982:																			
J	999	999	12	13	19	7	8	3	1	2	3	6	1	2	6	6	2	3	1
F	999	999	11	4	20	10	7	2	1	1	2	4	2	1	5	9	4	4	1
M	999	9	13	16	18	5	9	4	1	1	2	3	0	2	4	5	2	2	1
A	1	5	17	13	13	11	8	3	1	2	2	3	1	4	6	7	6	5	999
M	1	4	3	7	1	2	3	2	2	3	3	3	1	3	3	8	3	999	999
J	1	7	10	12	1	9	5	1	2	2	2	2	2	5	8	8	3	999	999
J	0	3	9	11	6	3	2	1	3	3	2	3	1	4	4	8	7	999	999
A	1	3	8	11	7	4	1	1	2	2	2	2	2	4	6	7	1	999	999
S	0	1	3	6	3	2	2	1	3	3	3	2	4	3	3	5	1	3	999
O	999	1	4	4	2	5	2	1	1	2	2	4	3	3	3	5	10	1	0
N	999	999	5	11	7	4	5	1	3	3	3	3	2	3	1	3	4	2	2
D	999	999	19	20	12	8	7	4	2	2	2	2	1	2	4	4	3	2	0
1983:																			
J	999	999	9	20	19	5	7	4	2	2	2	2	1	3	5	7	6	1	0
F	999	999	17	27	16	7	8	4	2	2	1	4	1	1	3	4	1	1	0
M	999	5	2	15	16	11	7	6	1	2	2	1	1	2	4	3	2	2	1
A	3	3	2	11	13	4	5	1	0	0	0	0	0	3	2	4	3	2	999
M	1	5	3	5	6	3	5	3	2	1	1	2	0	1	5	9	2	999	999
J	1	2	6	6	6	8	3	2	1	1	1	1	3	5	2	4	2	999	999
J	0	1	6	7	2	1	4	1	2	2	1	2	1	4	5	3	3	999	999
A	2	8	13	9	1	2	2	0	2	1	1	2	3	1	4	4	1	999	999
S	3	4	7	7	7	4	1	1	2	1	2	2	2	3	4	7	2	2	999
O	999	1	4	8	4	3	3	1	2	1	1	2	2	2	5	5	4	4	1
N	999	999	14	17	7	8	4	2	1	1	2	1	3	3	6	9	6	1	2
D	999	999	8	14	13	8	9	3	2	2	3	4	1	3	7	6	2	2	1
1984:																			
J	999	999	7	17	20	12	8	3	2	2	3	3	1	2	4	3	1	2	0
F	999	999	12	19	21	12	7	4	2	2	3	3	1	2	3	7	3	1	0
M	999	3	8	12	23	20	11	6	1	1	1	3	0	2	9	12	6	2	1
A	1	9	22	8	16	16	6	5	1	1	1	3	1	2	1	1	4	4	999
M	0	4	9	4	6	4	2	2	1	2	2	2	3	2	2	4	5	999	999
J	2	4	6	5	2	4	3	1	1	2	3	2	3	7	9	11	5	999	999
J	1	4	5	4	6	1	1	1	1	1	2	2	1	1	3	4	3	999	999
A	1	4	8	6	2	1	1	0	1	1	2	2	3	3	3	3	1	999	999
S	2	3	5	3	5	3	1	1	1	1	1	2	2	1	3	7	3	2	999
O	999	5	3	5	4	4	2	1	0	1	2	3	0	3	8	10	3	3	0
N	999	999	7	7	7	7	2	1	2	2	2	4	1	4	5	2	2	2	0
D	999	999	13	15	9	5	9	3	1	1	2	2	2	2	3	7	4	3	2
1985:																			
J	999	999	4	23	28	9	9	4	2	3	4	5	1	2	4	8	4	1	1
F	999	999	5	18	25	10	9	0	2	2	2	4	1	1	4	7	1	2	1
M	999	3	12	13	10	6	10	1	2	1	1	3	1	1	7	7	4	3	2
A	1	4	11	6	4	8	5	3	0	0	1	0	0	2	1	4	1	3	999

Table 3. (continued)

M	0	1	9	15	6	2	6	2	1	2	2	3	1	3	3	4	3	999	999
J	1	3	6	6	8	3	3	2	2	2	2	4	3	1	6	8	1	999	999
J	0	2	2	7	2	1	1	1	1	1	2	2	4	6	8	7	2	999	999
A	1	4	3	8	5	1	1	1	2	1	2	1	1	2	4	7	1	999	999
S	0	4	5	11	8	3	2	1	2	1	1	2	3	2	4	6	2	2	999
O	999	2	4	7	6	4	3	1	1	0	1	1	1	3	5	4	2	5	0
N	999	999	16	17	14	7	6	2	2	0	1	3	2	6	7	3	6	5	1
D	999	999	6	13	17	7	8	4	1	1	2	3	0	1	2	7	7	2	1
1986:																			
J	999	999	14	19	19	10	4	3	2	1	2	3	1	1	3	4	3	0	0
F	999	999	5	18	21	8	9	3	1	1	1	3	0	2	6	8	5	2	1
M	999	4	3	5	10	10	6	4	2	1	2	4	1	1	3	6	3	1	1
A	2	3	8	15	17	4	9	4	1	1	2	2	1	1	3	2	1	0	999
M	0	1	7	7	7	7	3	2	2	1	1	1	2	6	9	5	5	999	999
J	0	1	13	18	7	7	3	1	2	2	2	2	2	4	3	9	9	999	999
J	0	3	9	7	6	4	1	1	2	1	1	2	2	6	5	2	4	999	999
A	1	2	4	7	6	3	1	1	2	1	2	2	3	4	6	8	4	999	999
S	1	4	11	10	4	3	3	1	2	2	1	1	2	5	7	4	2	3	999
O	999	1	7	12	8	8	4	3	1	0	0	2	1	5	8	6	10	6	0
N	999	999	3	9	7	6	5	2	1	1	2	3	2	2	2	3	3	4	0
D	999	999	9	13	16	6	7	4	2	2	3	4	3	1	2	5	3	3	1
1987:																			
J	999	999	11	20	18	11	9	4	2	2	3	3	1	2	7	8	3	2	0
F	999	999	6	17	23	8	8	4	1	1	2	5	1	1	9	10	8	1	0
M	999	1	8	13	24	18	7	4	1	1	1	3	1	2	6	7	7	0	1
A	1	8	5	9	13	10	6	3	1	1	1	3	0	2	5	6	2	4	999
M	1	7	10	5	3	4	4	1	2	2	2	2	1	3	3	8	3	999	999
J	1	2	2	10	4	3	3	2	2	2	3	2	1	2	9	7	2	999	999
J	1	3	5	5	3	2	4	1	2	3	3	3	2	1	6	7	3	999	999
A	1	1	9	11	4	2	2	1	1	2	2	1	2	4	5	7	1	999	999
S	1	4	5	9	6	5	1	0	1	2	2	3	2	6	7	2	5	4	999
O	999	1	5	4	4	3	2	2	1	2	3	1	2	3	5	7	7	3	0
N	999	999	7	6	7	9	4	2	1	1	2	3	2	4	2	3	7	4	2
D	999	999	11	15	11	12	7	2	2	1	1	3	2	2	3	3	4	1	1
1988:																			
J	999	999	9	16	15	7	5	2	2	1	1	4	2	1	4	6	3	2	0
F	999	999	16	20	20	5	10	3	2	2	2	5	2	2	2	9	5	2	0
M	999	7	3	19	21	8	7	3	1	1	1	3	2	2	3	4	1	3	1
A	0	5	13	16	13	16	7	4	1	1	1	2	1	2	7	9	2	3	999
M	1	2	8	8	5	8	5	4	1	2	2	1	2	3	6	6	2	999	999
J	1	5	13	11	5	6	2	1	1	2	2	2	2	3	8	7	2	999	999
J	1	5	5	12	5	5	1	0	2	2	2	3	3	2	3	8	1	999	999
A	0	4	5	10	6	3	1	1	2	2	2	3	2	2	6	10	1	999	999
S	1	2	6	9	3	5	1	1	2	0	1	3	1	2	7	2	6	1	999
O	999	2	4	9	11	6	2	1	1	1	1	3	1	6	6	12	10	2	0
N	999	999	9	12	12	13	6	3	1	1	1	1	1	2	4	8	5	3	0
D	999	999	16	27	21	7	6	3	1	1	2	2	1	2	2	3	4	5	1
1989:																			
J	999	999	12	17	11	2	5	3	3	3	3	4	1	1	4	7	2	1	1
F	999	999	17	19	12	3	5	4	3	2	3	5	2	1	5	8	3	0	1
M	999	10	16	13	10	11	4	3	2	1	2	3	0	1	5	7	2	3	0
A	2	2	8	8	8	3	6	3	1	1	1	1	1	3	3	6	5	3	999
M	1	3	6	4	12	5	5	4	0	1	1	2	2	1	5	5	2	999	999
J	1	3	6	9	4	6	4	1	1	1	1	0	0	1	2	4	0	999	999
J	0	0	4	6	2	3	2	0	1	1	1	2	3	0	6	8	5	999	999
A	1	4	9	9	3	2	1	1	2	1	2	3	1	4	8	11	4	999	999
S	1	1	4	7	1	2	1	0	1	1	2	3	2	1	6	6	5	2	999
O	999	2	6	6	6	7	4	1	1	1	2	3	2	4	8	9	5	5	1
N	999	999	9	11	6	5	7	2	2	2	3	2	1	3	2	5	4	3	0
D	999	999	12	23	23	4	5	3	2	3	3	3	2	2	6	4	6	4	1
1990:																			
J	999	999	31	21	15	14	8	2	1	2	2	3	1	2	5	3	1	2	0
F	999	999	17	17	6	2	4	1	2	2	1	3	1	1	9	13	9	7	1
M	999	5	16	27	16	4	7	2	2	2	2	3	1	1	2	2	1	3	0
A	1	3	6	6	7	4	4	2	1	1	2	1	1	1	9	7	6	3	999
M	0	4	17	15	12	10	5	2	1	1	2	1	1	1	3	2	2	999	999
J	2	3	4	4	6	2	4	1	2	2	2	3	2	1	1	3	4	999	999
J	0	2	4	12	6	4	1	1	3	2	3	3	2	1	7	10	6	999	999
A	1	1	5	10	1	2	0	1	3	2	2	2	2	1	2	4	1	999	999
S	1	2	8	16	7	3	2	0	2	2	2	3	2	6	4	8	4	4	999
O	999	1	3	3	7	6	2	2	2	1	1	2	1	1	2	1	3	3	0
N	999	999	8	9	4	2	5	2	2	0	2	3	1	1	4	7	4	1	1
D	999	999	7	15	15	10	9	3	2	2	2	2	2	1	1	5	2	2	1
1991:																			
J	999	999	13	18	20	12	12	3	2	2	3	4	1	1	4	7	2	1	0
F	999	999	7	10	20	11	7	6	1	1	1	4	1	1	10	14	10	2	1
M	999	11	17	13	11	8	10	5	1	0	1	3	1	3	6	6	3	2	0
A	0	3	7	7	15	11	9	3	1	0	1	2	1	2	3	2	1	2	999
M	1	1	8	9	5	8	7	3	1	1	2	2	2	3	3	5	4	999	999
J	1	5	3	8	3	5	5	2	0	1	1	2	2	4	5	7	2	999	999
J	1	4	6	11	5	4	2	1	1	1	1	2	3	4	5	6	1	999	999
A	0	5	13	20	6	3	1	0	1	1	2	2	2	1	5	3	3	999	999
S	0	1	8	14	6	5	1	0	3	3	2	2	4	7	6	3	1	1	999
O	999	1	3	7	3	3	3	2	2	2	1	5	2	8	14	13	6	6	1
N	999	999	1	6	12	6	6	3	1	1	1	5	1	2	3	8	12	5	1
D	999	999	11	13	10	5	5	1	1	1	1	3	2	1	3	1	1	1	1
1992:																			
J	999	999	13	23	20	6	10	4	2	1	1	3	2	4	5	8	5	3	0

Table 3. (continued)

ZONAL WAVE-3 PHASE(DEG)

LATITUDE

	85N	75N	65N	55N	45N	35N	25N	15N	5N	EQU	5S	15S	25S	35S	45S	55S	65S	75S	85S
1978:																			
N	999	999	-27	-28	-61	-113	108	76	159	106	106	173	102	77	15	19	61	4	-38
D	999	999	-63	-64	-81	-124	128	60	167	154	138	156	128	169	172	-168	-135	-39	-74
1979:																			
J	999	999	-98	-92	-86	-128	83	58	171	163	137	153	101	80	180	-138	-144	-102	169
F	999	999	-168	-51	-60	149	95	25	154	-175	161	155	140	120	-156	-102	-34	-11	112
M	999	-178	-152	-106	-55	-131	95	54	145	173	137	147	-10	72	-164	-158	171	27	24
A	21	-81	-55	-97	-104	-149	65	8	-172	121	112	-169	0	140	178	157	156	22	999
M	-179	-165	142	99	-69	-119	76	5	24	117	112	13	-81	-147	109	106	97	999	999
J	116	-77	-20	-43	-45	179	16	-48	-172	167	175	-123	-28	108	120	89	71	999	999
J	-66	-50	-31	-83	-110	-167	10	5	176	-178	-171	-126	46	113	156	163	-176	999	999
A	-84	-86	-53	0	141	117	-7	-2	163	168	-170	-139	81	-179	-41	-105	-103	999	999
S	154	121	-74	37	104	156	13	163	158	163	-177	-158	169	-153	79	-106	-96	-38	999
O	999	17	-104	-50	-128	-162	102	30	153	136	144	161	165	26	47	72	156	2	76
N	999	999	-55	-85	-140	-175	52	-62	-131	176	173	-148	15	81	135	-136	-110	-53	51
D	999	999	-2	-44	-56	-106	149	68	162	163	148	167	154	115	159	-152	-39	-32	-90
1980:																			
J	999	999	-135	-80	-63	-27	122	50	177	165	158	167	87	4	175	-168	-139	-76	-59
F	999	999	-111	-19	-33	-70	146	60	133	179	163	171	41	69	-154	-126	-97	-58	-101
M	999	-41	-75	-84	-76	-141	92	31	-121	-150	166	159	-161	109	139	180	-120	-12	-3
A	-131	-26	4	-52	-121	-167	82	56	-123	-166	135	174	-119	137	163	-176	32	18	999
M	129	-174	-22	-31	-123	-143	52	-9	-166	176	174	-148	-9	99	168	148	119	999	999
J	145	-67	-2	-14	-125	123	17	-96	153	152	166	-117	-103	125	124	139	-51	999	999
J	146	-54	-6	7	-128	-176	-20	-43	158	157	146	-167	-63	17	70	76	73	999	999
A	23	63	29	-8	-44	-154	-47	41	141	155	117	-89	57	112	116	141	-64	999	999
S	87	108	-73	-16	-48	175	28	-77	175	-174	175	-154	5	50	141	-178	-20	82	999
O	999	-65	-54	-57	-75	-169	83	25	172	131	137	-145	139	116	139	162	66	6	-44
N	999	999	-71	-44	-8	106	124	57	-166	115	116	160	156	-36	30	52	85	53	97
D	999	999	-75	-65	-50	-117	143	104	-166	157	129	-171	177	134	160	-168	-175	-19	-61
1981:																			
J	999	999	-38	-47	-52	-106	152	129	157	155	140	143	132	-164	-29	22	44	-16	-47
F	999	999	-13	-82	-87	-111	111	69	150	153	152	139	132	121	157	-170	-120	-19	-119
M	999	-141	-47	-40	-36	-84	155	92	127	117	94	167	-138	148	149	145	170	72	131
A	9	-74	-73	-71	-63	113	73	31	-164	176	145	-162	-30	114	-177	163	-144	-11	999
M	140	-56	-21	-24	-98	-125	26	-4	171	168	167	-118	-16	65	-140	-148	-136	999	999
J	-151	-125	144	58	-20	-106	19	-16	-132	179	-169	35	23	-153	-169	155	108	999	999
J	-159	70	48	69	14	-136	-68	20	151	141	169	-154	-33	-47	-141	162	164	999	999
A	-75	15	45	63	121	-154	130	85	168	159	167	-159	-176	-125	88	83	-63	999	999
S	-159	-113	-77	84	126	-132	-33	-78	152	138	155	-172	-40	122	138	-159	10	33	999
O	999	-3	179	-149	-140	162	33	-47	-145	114	128	178	-85	19	85	126	-60	12	72
N	999	999	-78	-85	-111	-157	81	10	-154	75	91	-166	77	-135	-154	-147	129	44	49
D	999	999	-30	-83	-103	-118	110	68	172	166	134	142	93	146	-165	-170	-137	-8	19
1982:																			
J	999	999	-154	-77	-64	-93	111	72	128	145	146	157	116	109	-178	-163	-52	14	85
F	999	999	155	-34	-82	-91	132	87	102	136	145	143	120	139	-151	-136	-88	-39	-47
M	999	-105	-101	-96	-98	-155	73	28	-157	-174	144	172	-154	101	-151	-113	-101	8	38
A	-119	-73	-84	-111	-146	172	67	4	165	155	139	156	97	170	-151	-171	-165	6	999
M	10	-113	-87	75	-22	178	62	4	156	163	162	-174	55	143	178	-153	-178	999	999
J	-150	-98	-52	-26	-101	-166	55	-66	-171	175	162	-168	-111	103	119	149	125	999	999
J	34	-42	8	9	-52	-138	-6	-23	159	157	163	162	-156	144	95	69	42	999	999
A	-131	-46	22	26	-10	-129	-61	-94	145	148	155	-162	128	118	136	120	-42	999	999
S	137	131	92	39	46	-146	28	-174	159	157	170	-153	61	102	-167	169	65	37	999
O	999	14	53	-18	-102	168	51	-43	163	129	135	-163	180	81	16	-127	-113	7	104
N	999	999	-83	-53	-83	-172	75	28	149	135	137	176	140	36	75	-141	-150	39	96
D	999	999	-63	-94	-129	175	72	-46	-169	168	151	179	121	140	-177	-97	-89	-22	27
1983:																			
J	999	999	-75	-49	-42	-94	135	87	158	145	113	-168	108	128	-148	-123	-119	-163	93
F	999	999	-70	-69	-77	-126	116	124	152	153	129	-176	-149	101	119	170	-106	-69	-102
M	999	79	-93	-68	-49	-95	131	95	130	139	122	173	144	-125	-42	-16	28	14	-40
A	-122	177	163	-171	-172	146	60	-35	164	150	121	104	2	153	-155	110	138	125	999
M	-26	-85	-71	96	-146	180	44	-93	179	150	154	113	-45	124	112	116	103	999	999
J	-171	3	-40	-11	-72	-138	74	-3	-147	176	150	-40	-37	14	58	52	22	999	999
J	117	9	32	24	113	-121	-16	-112	161	151	174	-112	-31	9	1	-111	-132	999	999
A	8	19	38	31	67	175	-43	-6	178	175	-169	-129	-34	-137	136	133	-47	999	999
S	69	93	67	55	-33	-136	-2	-107	167	148	167	-145	-38	58	112	178	-50	23	999
O	999	108	-14	-28	-63	-155	56	-46	163	111	137	-151	75	170	142	157	-169	18	14
N	999	999	-22	-15	-47	-154	104	34	167	95	89	158	45	150	-143	-149	-175	78	106
D	999	999	-108	-87	-104	-152	107	48	147	121	119	171	31	97	164	-166	-139	-119	-77
1984:																			
J	999	999	-109	-93	-85	-108	117	63	148	141	128	149	121	127	145	102	125	1	153
F	999	999	-69	-81	-93	-127	94	51	130	142	117	142	-104	25	-169	-133	-117	-92	150
M	999	2	-38	-53	-82	-126	128	52	-5	-99	148	143	-101	45	151	170	-174	42	-34
A	141	34	45	34	-77	-127	112	17	-61	-120	179	-173	-101	111	-176	-73	-68	-21	999
M	160	32	42	76	-93	-110	57	5	-161	-156	-150	-146	-140	-68	-4	53	61	999	999
J	-121	-76	-26	20	-171	-134	-25	-20	139	163	175	-173	-38	55	87	101	84	999	999
J	61	-65	-13	75	97	-23	-26	54	132	155	-175	-150	108	70	-39	73	122	999	999
A	-108	-3	-21	17	165	-133	-4	91	163	-177	-155	-179	-14	30	132	127	179	999	999
S	-130	-107	-39	-44	-147	164	68	55	131	131	160	-177	77	-143	-168	-164	135	55	999
O	999	-116	-172	94	-166	-159	61	-6	-165	96	134	-164	151	94	153	163	16	20	-20
N	999	999	-34	-95	-108	-135	99	-18	-170	144	138	175	121	76	79	61	-36	-33	-162
D	999	999	-143	-121	-133	152	79	-3	-142	146	119	156	96	76	-147	158	130	49	14
1985:																			
J	999	999	69	-42	-55	-125	144	144	162	167	161	168	149	113	-168	-158	-114	-73	-169
F	999	999	-42	-62	-68	-117	101	124	138	139	141	139	173	1	-179	-164	-109	-36	-112
M	999	-113	-103	-59	-114	173	89	33	-149	-166	154	155	-110	11	90	108	74	0	148
A	173	-80	-44	-27	-77	-160	94	23	17	72	88	177	27	156	-90	124	124	-16	999

Table 3. (continued)

M	-12	138	0	3	-21	179	46	-26	170	162	166	-133	-33	45	133	139	99	999	999
J	136	-91	-49	44	-36	-154	24	-14	157	152	154	173	-127	-169	134	156	-155	999	999
J	108	174	102	-6	10	176	-21	28	156	171	-178	-156	98	136	170	164	-113	999	999
A	-86	-105	120	76	30	-71	-28	34	163	177	170	-165	60	141	134	118	95	999	999
S	157	107	5	-38	-81	-169	3	-27	161	171	167	-167	30	146	167	-162	-103	35	999
O	999	-174	93	-3	-65	175	78	-28	-122	143	142	-140	77	133	146	-166	69	42	3
N	999	999	-111	-110	-133	159	97	27	-135	-150	130	-140	-20	111	125	-168	-112	-49	101
D	999	999	-128	-18	-40	-130	135	97	-173	174	130	154	-97	-64	132	133	151	115	139
1986:																			
J	999	999	-129	-85	-92	-124	139	74	173	156	135	155	96	121	-162	-151	-152	164	56
F	999	999	-56	-50	-68	-110	145	105	83	96	98	163	178	159	-175	-162	-155	-74	160
M	999	-27	110	73	-39	-104	126	69	152	155	124	155	-104	41	-177	-145	-144	7	-64
A	119	-56	-129	-165	-153	-167	54	69	130	124	111	151	172	-34	177	-178	-64	-116	999
M	25	-176	23	71	-87	-95	79	32	-148	-160	164	-145	-69	57	68	71	-2	999	999
J	-129	160	10	12	-4	-157	20	-54	-175	161	158	-146	-140	-93	-69	-63	-89	999	999
J	139	-39	-27	-27	-89	-139	-8	-18	-177	-173	-163	-118	99	150	130	77	-7	999	999
A	-134	-78	-10	54	42	-149	-144	132	-176	178	-178	169	-101	-28	91	128	23	999	999
S	30	-7	-19	-46	-161	140	15	-59	-170	-175	-178	-121	19	154	-177	-147	-40	29	999
O	999	-53	-11	-9	-49	-165	82	-15	-146	127	178	-99	0	148	167	-177	-79	22	-1
N	999	999	104	-32	-40	-117	110	19	170	137	121	174	-142	161	-152	-119	-47	48	90
D	999	999	42	-10	-34	-97	140	78	154	150	135	170	137	75	-172	146	135	21	39
1987:																			
J	999	999	-72	-63	-67	-133	138	73	164	167	159	166	140	98	-168	-177	170	152	41
F	999	999	-47	-53	-44	-102	131	82	130	154	148	158	-86	55	-143	-123	-122	-95	-161
M	999	2	-88	-91	-83	-105	114	79	179	-112	166	169	-177	125	-166	-112	-91	-79	160
A	-49	-10	32	1	-70	-105	104	52	173	-166	178	-171	-93	-121	174	166	-155	0	999
M	20	-98	-71	42	137	112	39	-46	-177	179	-170	-138	-82	-43	91	124	147	999	999
J	-164	162	36	61	60	-149	25	-72	176	-173	-160	-132	-82	120	88	82	72	999	999
J	-36	-57	-54	-34	-11	166	10	7	144	159	179	-173	-154	-153	133	92	18	999	999
A	-124	-131	-83	-64	-30	-174	-49	-70	140	154	-168	-101	60	143	-144	-160	37	999	999
S	-44	64	54	58	43	-151	39	-84	163	153	174	-143	-91	53	79	93	-92	-29	999
O	999	87	53	26	-45	-140	77	-38	-177	137	145	-173	30	80	140	135	-24	-30	6
N	999	999	-94	-61	-76	-164	98	-56	-154	107	117	-144	43	105	-147	89	52	41	65
D	999	999	-50	-32	-65	-151	157	140	-166	-167	167	-163	89	75	-164	-179	151	145	33
1988:																			
J	999	999	-65	-51	-56	-119	153	179	159	154	104	165	160	174	120	92	82	45	50
F	999	999	-85	-81	-49	-95	126	104	149	126	133	158	152	107	-112	-137	-131	22	160
M	999	52	-95	-76	-63	-115	119	94	-131	-163	135	142	-174	-161	-117	-110	-115	11	-114
A	-88	-60	-26	-43	-100	-143	99	58	127	132	106	-175	-175	79	100	95	79	9	999
M	115	-31	-11	38	-106	-137	40	-5	-132	-161	-166	-62	-31	134	108	88	117	999	999
J	-50	27	27	49	-17	-133	15	-34	-168	177	-171	-119	-72	74	94	103	105	999	999
J	34	69	65	69	17	-109	-136	59	158	175	170	-151	70	110	113	109	167	999	999
A	40	-3	34	56	49	-146	-94	38	155	161	171	-170	-134	68	63	56	-116	999	999
S	160	68	47	3	-91	-178	67	116	149	143	113	-170	-62	62	92	68	-41	-94	999
O	999	115	33	0	-41	-103	82	15	158	101	114	-169	-166	63	144	165	87	23	97
N	999	999	-26	-44	-88	-149	100	25	-164	136	75	-168	106	60	135	-175	171	141	114
D	999	999	-7	-26	-53	-98	135	68	165	153	127	145	90	87	161	-176	-32	-28	-62
1989:																			
J	999	999	-34	-44	-44	170	103	68	135	131	125	150	155	97	147	150	-161	9	46
F	999	999	-40	-48	-73	-42	104	75	125	138	143	147	-171	33	146	-175	-150	-73	140
M	999	-131	-104	-89	-110	-103	84	49	57	63	108	143	-63	108	-157	-120	-92	8	23
A	-39	146	-32	-50	-75	-165	76	25	136	-179	139	172	-64	122	121	114	86	34	999
M	-102	-114	-19	-27	-107	-156	45	-7	-150	-149	162	-142	17	-172	-173	-168	-164	999	999
J	-149	131	81	45	-28	-141	15	10	119	160	-167	-103	-5	63	50	58	31	999	999
J	-3	-109	37	27	10	-127	-34	-140	162	177	-164	-146	-171	-61	-157	175	173	999	999
A	57	17	24	26	44	-165	-5	42	158	179	-155	-138	43	-156	-148	-159	-142	999	999
S	-1	49	-15	-5	-168	-174	-3	139	145	156	176	-166	-73	107	142	161	-29	-2	999
O	999	-9	-65	-26	-108	176	34	-12	168	123	131	-174	70	130	144	170	76	12	47
N	999	999	-87	-77	-96	168	92	47	-162	173	153	171	53	126	-87	-36	61	73	-8
D	999	999	-65	-60	-42	-125	139	88	146	159	164	166	133	-178	-128	-114	-55	-87	100
1990:																			
J	999	999	-116	-91	-108	-161	127	43	177	165	148	167	-134	113	144	149	-138	-65	96
F	999	999	-34	-57	-35	159	107	100	-153	-149	-172	-178	-155	55	121	150	-161	-120	42
M	999	-104	-30	-31	-46	-142	105	65	174	179	162	154	-150	-21	104	-170	78	-8	180
A	-156	150	-46	-71	-89	-148	80	62	-152	163	134	-152	-69	121	95	49	13	-31	999
M	156	-62	-30	-27	-85	-169	54	-42	175	157	164	-136	-86	72	69	-69	150	999	999
J	-88	-45	-24	47	-133	172	21	-37	176	175	-157	-61	-21	9	66	-69	-116	999	999
J	74	-160	-17	26	29	-122	-31	73	175	158	160	-162	-80	-17	166	-153	-147	999	999
A	-58	119	-14	3	63	-169	-1	177	172	-167	-150	-144	113	176	-170	74	-58	999	999
S	20	48	17	-23	-83	159	13	-73	165	171	167	-157	38	63	112	137	-153	12	999
O	999	-13	-9	-17	-142	180	34	-91	-166	-170	159	-144	83	179	147	166	-124	8	58
N	999	999	-71	-87	-75	-79	95	9	-160	-154	106	-178	-173	99	128	146	133	-62	-4
D	999	999	-93	-91	-116	168	101	49	173	156	131	-165	87	102	147	128	174	90	104
1991:																			
J	999	999	-33	-24	-61	-134	130	75	150	154	145	164	116	124	-104	-104	-70	81	-178
F	999	999	-120	-52	-57	-98	136	80	145	159	126	149	167	71	-158	-126	-106	-42	128
M	999	-108	-107	-104	-96	-178	80	58	130	-152	97	170	174	114	-146	-144	-123	-11	-162
A	-175	111	-100	-106	-129	170	63	4	127	136	89	-172	129	147	-119	-143	17	19	999
M	67	163	-32	7	-117	158	57	-18	152	158	163	-150	106	145	149	41	8	999	999
J	77	173	148	81	-54	-130	44	-51	158	161	-158	-155	-73	92	109	71	38	999	999
J	-148	72	41	43	-22	-129	5	-29	-145	-92	-126	-138	29	101	98	83	47	999	999
A	25	73	53	30	-3	-155	57	-129	-165	-109	-108	-158	148	-112	-144	-135	44	999	999
S	-147	1	-19	-2	-48	-175	76	-101	-163	-153	-116	-71	67	115	110	130	-18	-40	999
O	999	25	-83	-92	-155	127	38	-39	-177	-159	-142	-137	-45	72	119	160	-109	21	56
N	999	999	129	-89	-80	-167	90	50	-179	-125	162	-164	146	19	50	84	64	22	79
D	999	999	-43	-46	-52	-130	124	12	136	145	112	178	-153	-139	98	127	150	-23	53
1992:																			
J	999	999	-60	-41	-25	-110	153	119	122	-175	175	180	135	122	-160	-141	-129	-58	-55

Table 3. (continued)

ZONAL WAVES 4-7 AMPLITUDE(DU)

LATITUDE

	85N	75N	65N	55N	45N	35N	25N	15N	5N	EQU	5S	15S	25S	35S	45S	55S	65S	75S	85S
1978:																			
N	999	999	3	6	4	7	3	1	2	1	2	4	4	5	7	4	3	3	1
D	999	999	4	9	9	6	4	1	2	2	1	3	2	3	7	7	5	3	1
1979:																			
J	999	999	7	10	9	9	7	1	2	2	2	3	4	7	8	6	3	3	1
F	999	999	7	16	15	13	4	2	1	2	1	2	2	4	6	4	2	3	1
M	999	8	16	15	10	10	5	3	2	1	1	3	3	5	3	4	3	3	1
A	1	7	18	13	14	11	4	2	2	2	1	2	2	4	3	5	4	2	999
M	1	4	13	14	11	13	6	2	1	2	2	3	4	9	8	5	2	999	999
J	1	6	8	13	9	12	4	2	2	2	2	2	3	6	9	7	5	999	999
J	1	4	5	9	13	6	2	2	2	2	2	2	3	5	3	2	2	999	999
A	1	5	10	9	9	5	2	1	2	2	2	2	5	7	4	4	3	999	999
S	1	2	4	9	9	4	2	2	2	1	2	2	5	7	5	3	2	1	999
O	999	2	6	7	13	8	2	2	2	2	2	3	5	3	9	5	4	2	1
N	999	999	4	7	13	11	3	2	2	1	2	4	4	4	4	4	4	5	1
D	999	999	3	5	11	7	1	1	2	2	2	3	3	5	10	7	4	3	1
1980:																			
J	999	999	3	13	10	8	4	1	2	2	2	3	3	4	7	4	2	2	1
F	999	999	11	14	14	11	4	1	1	1	2	2	2	5	9	6	3	4	1
M	999	5	9	9	8	8	6	2	2	2	2	2	3	4	7	5	3	2	0
A	1	4	10	20	25	11	6	4	2	2	1	3	4	10	13	7	2	1	999
M	1	4	9	16	13	8	5	2	1	2	2	2	3	10	14	11	4	999	999
J	1	5	11	9	13	12	3	2	2	2	1	2	3	5	7	5	3	999	999
J	1	3	6	7	10	6	2	2	2	2	2	2	4	6	4	4	4	999	999
A	1	2	8	8	8	7	3	1	3	2	2	2	4	3	5	3	2	999	999
S	1	2	5	5	10	7	3	2	1	1	2	2	4	7	5	3	2	2	999
O	999	3	3	8	15	6	3	1	2	1	2	3	6	6	5	5	3	2	1
N	999	999	5	6	8	6	3	1	1	2	2	3	4	5	5	5	5	4	1
D	999	999	3	13	20	15	5	2	1	1	1	3	4	4	7	4	3	3	1
1981:																			
J	999	999	7	17	18	13	4	3	2	1	1	3	3	4	6	3	4	2	1
F	999	999	4	7	5	5	4	2	2	1	1	3	2	3	7	8	3	2	1
M	999	4	7	6	10	13	4	1	1	1	2	3	3	5	10	6	3	1	1
A	1	2	5	11	12	13	8	3	2	2	1	2	2	3	3	4	4	1	999
M	1	3	11	12	13	11	5	2	2	1	2	2	5	11	9	7	3	999	999
J	0	5	7	10	9	7	3	1	2	2	2	2	5	6	5	4	3	999	999
J	1	4	7	9	10	5	2	2	3	2	1	2	2	5	8	8	4	999	999
A	1	2	7	12	9	5	3	1	3	2	2	2	4	5	8	5	2	999	999
S	1	2	4	8	10	5	2	1	2	2	2	2	4	6	6	7	3	1	999
O	999	3	7	9	8	6	3	1	2	2	2	2	4	5	5	2	1	2	1
N	999	999	4	12	14	9	3	2	2	1	1	3	4	4	4	2	4	1	1
D	999	999	8	6	7	8	4	2	1	1	2	3	4	4	8	6	4	4	1
1982:																			
J	999	999	8	8	12	10	5	1	2	1	1	3	3	4	8	7	6	3	1
F	999	999	9	22	14	6	4	1	2	2	1	2	3	3	9	7	3	2	1
M	999	5	6	7	14	10	4	2	2	2	2	2	2	3	8	5	2	2	1
A	1	3	6	15	11	9	6	1	2	3	2	2	2	6	6	4	4	2	999
M	1	5	10	7	6	11	8	1	1	2	2	1	1	4	5	4	4	999	999
J	0	3	7	8	7	12	4	2	3	2	1	2	5	9	9	6	4	999	999
J	1	2	7	7	8	8	3	1	3	2	2	2	4	4	3	4	2	999	999
A	0	2	3	8	10	4	2	1	3	2	2	3	3	5	5	4	2	999	999
S	1	2	6	7	8	6	3	1	2	2	2	2	3	7	5	4	2	2	999
O	999	2	4	7	8	7	3	1	1	2	3	2	4	4	2	4	3	3	1
N	999	999	4	5	6	8	3	2	1	1	3	3	4	4	3	2	4	3	1
D	999	999	7	9	13	13	6	3	1	1	2	3	3	3	7	5	2	3	1
1983:																			
J	999	999	4	10	10	10	7	4	2	1	1	2	2	3	6	5	4	2	1
F	999	999	5	8	12	9	8	5	1	1	2	3	5	5	11	9	2	2	1
M	999	7	6	7	6	7	7	4	2	2	1	2	3	4	6	3	2	3	1
A	1	4	13	17	12	10	5	1	2	2	2	2	3	4	5	4	2	2	999
M	1	6	16	16	10	10	7	3	2	2	2	2	3	6	7	6	3	999	999
J	1	1	5	8	7	9	5	2	2	2	2	3	5	6	5	6	3	999	999
J	1	4	6	9	12	7	2	2	2	2	2	3	3	5	3	4	1	999	999
A	1	2	6	10	12	6	2	1	3	2	2	3	5	8	5	5	1	999	999
S	1	2	6	6	6	5	2	1	3	2	3	2	5	7	4	4	3	1	999
O	999	2	3	5	9	6	2	2	2	1	2	2	3	6	4	2	2	2	1
N	999	999	6	4	6	8	2	2	1	1	2	3	3	4	4	3	4	2	1
D	999	999	7	7	8	10	3	1	1	1	1	3	3	2	7	6	2	3	1
1984:																			
J	999	999	6	12	10	6	3	2	2	2	1	2	3	3	6	4	4	1	1
F	999	999	7	18	12	11	7	3	1	1	1	2	2	4	6	4	4	3	1
M	999	6	12	14	12	8	6	2	2	2	1	2	1	5	8	3	2	4	1
A	1	3	8	11	11	9	5	2	2	2	2	1	1	4	5	6	4	2	999
M	1	4	15	15	16	12	5	2	2	2	1	3	3	3	9	11	6	999	999
J	1	4	7	10	9	6	3	1	2	2	2	1	6	8	8	4	4	999	999
J	1	4	4	12	13	5	3	2	3	2	1	3	2	4	3	3	2	999	999
A	1	4	5	7	13	5	1	2	2	2	1	1	2	5	3	6	2	999	999
S	1	5	5	7	8	6	2	1	2	2	2	2	4	7	3	3	1	3	999
O	999	2	4	9	9	8	4	1	2	2	2	3	6	8	7	5	2	2	1
N	999	999	8	7	6	5	2	1	2	1	2	3	3	5	3	3	2	2	1
D	999	999	8	6	5	6	5	2	2	1	2	4	3	6	9	5	2	2	1
1985:																			
J	999	999	7	17	17	10	5	2	1	1	1	3	2	2	5	3	4	3	1
F	999	999	6	17	19	14	5	2	2	2	1	1	2	4	5	2	2	2	0
M	999	5	14	11	16	13	3	2	2	1	2	2	2	3	7	4	2	2	1
A	1	9	14	16	15	11	4	1	2	2	2	2	2	5	7	4	1	1	999

Table 3. (continued)

M	1	5	9	10	14	10	6	2	2	2	2	2	2	4	4	3	3	999	999
J	1	2	7	8	10	8	3	1	2	2	2	3	6	12	9	5	2	999	999
J	0	3	3	6	11	7	3	1	2	2	2	3	5	6	3	6	3	999	999
A	1	2	6	9	7	6	2	1	2	2	2	2	5	5	4	5	3	999	999
S	1	3	7	11	9	6	2	1	2	2	2	2	3	7	7	4	2	1	999
O	999	1	4	7	6	5	3	2	2	2	2	3	5	7	4	2	3	2	1
N	999	999	5	6	9	8	2	1	1	1	2	3	4	7	8	4	5	2	1
D	999	999	7	7	13	13	3	2	1	1	1	3	5	4	2	2	2	2	1
1986:																			
J	999	999	5	14	20	12	4	3	2	1	1	2	3	3	4	2	3	1	1
F	999	999	7	8	9	15	5	2	2	1	1	2	2	3	5	4	3	2	0
M	999	4	6	12	12	10	4	2	2	1	1	2	2	4	10	5	2	3	1
A	1	7	11	13	9	11	8	3	2	2	2	1	2	6	3	2	2	2	999
M	1	4	6	14	14	13	8	3	1	1	2	2	3	3	5	3	2	999	999
J	0	2	6	8	10	9	3	1	3	2	2	3	4	6	5	5	4	999	999
J	1	3	7	5	9	5	2	2	3	1	2	2	5	11	6	3	1	999	999
A	1	4	5	10	9	6	3	1	3	2	2	2	3	5	6	3	4	999	999
S	0	3	8	4	9	8	3	1	2	1	1	2	5	8	4	3	2	1	999
O	999	3	5	5	7	6	3	2	2	2	2	3	2	5	3	2	3	2	1
N	999	999	3	5	5	7	4	1	2	1	2	4	6	5	6	4	3	2	1
D	999	999	8	3	4	5	3	2	1	1	1	3	5	5	4	3	3	2	1
1987:																			
J	999	999	12	7	8	7	3	1	2	2	2	4	3	3	4	3	2	2	1
F	999	999	12	9	11	11	5	3	2	2	1	3	3	3	6	5	4	1	1
M	999	6	9	11	14	15	2	1	1	2	1	2	1	2	2	2	2	3	1
A	1	6	7	16	18	16	4	2	2	2	1	2	3	7	5	4	2	1	999
M	1	4	14	19	17	10	5	2	2	2	2	1	3	5	5	5	2	999	999
J	1	5	15	14	9	10	4	1	2	2	1	2	2	5	4	4	4	999	999
J	1	2	5	5	9	6	3	2	2	2	1	2	4	8	8	7	3	999	999
A	0	2	5	6	7	5	2	1	2	1	2	3	3	2	1	1	1	999	999
S	0	3	3	8	11	7	3	1	1	2	2	2	2	4	2	3	2	1	999
O	999	4	6	9	15	10	3	2	1	2	3	3	4	3	3	2	3	1	0
N	999	999	6	9	8	5	3	1	2	1	2	3	4	3	1	2	2	2	1
D	999	999	4	7	13	15	7	3	1	1	2	4	4	4	3	3	3	2	1
1988:																			
J	999	999	7	6	10	11	6	3	2	1	1	2	2	3	6	4	2	2	1
F	999	999	12	17	14	9	9	3	2	1	1	2	2	4	6	5	2	2	1
M	999	9	19	20	14	7	5	1	2	1	1	2	2	6	9	6	4	1	1
A	1	3	8	8	12	14	4	1	1	1	1	2	2	4	7	4	2	2	999
M	1	4	10	10	14	8	6	2	1	2	1	2	3	4	4	3	3	999	999
J	0	4	7	15	16	10	2	2	2	2	2	2	3	4	3	4	3	999	999
J	1	5	7	9	8	5	3	1	2	2	2	2	3	6	5	5	2	999	999
A	1	2	4	7	4	6	3	1	2	2	2	3	2	5	4	7	3	999	999
S	1	1	2	5	11	6	3	2	2	2	3	2	2	5	5	6	4	1	999
O	999	1	3	7	15	7	2	2	1	1	2	3	4	5	7	4	5	2	1
N	999	999	3	7	12	8	3	2	1	1	2	3	3	5	6	3	3	2	1
D	999	999	9	8	8	7	4	1	2	1	2	3	4	6	10	6	3	3	1
1989:																			
J	999	999	5	8	5	7	5	1	2	1	1	2	1	3	3	2	2	2	1
F	999	999	21	20	11	5	3	2	2	1	1	3	2	4	6	4	3	2	1
M	999	4	7	18	17	7	3	1	2	2	1	2	1	2	5	5	1	2	1
A	1	5	14	13	20	11	5	1	2	1	1	2	2	3	5	3	3	2	999
M	1	5	8	5	10	10	4	1	1	1	2	2	2	3	2	1	2	999	999
J	1	5	13	11	7	7	4	2	2	2	2	2	2	3	3	2	2	999	999
J	1	4	6	10	14	7	3	2	2	2	2	2	2	3	4	4	2	999	999
A	1	4	6	5	6	6	3	1	2	2	2	3	6	6	5	5	3	999	999
S	1	3	3	6	9	6	3	2	3	2	2	2	4	3	3	5	2	2	999
O	999	2	3	9	11	8	2	1	2	2	1	3	4	5	3	4	3	2	1
N	999	999	4	9	11	8	3	2	2	1	2	4	2	5	6	6	2	3	1
D	999	999	8	9	10	9	2	2	2	1	2	3	3	5	10	6	5	2	1
1990:																			
J	999	999	16	13	10	8	5	1	2	1	1	2	3	3	6	3	3	2	1
F	999	999	13	9	10	10	3	1	2	1	1	3	2	4	4	2	2	3	1
M	999	5	6	12	9	6	5	2	2	2	1	2	1	3	3	4	2	1	1
A	1	3	5	13	13	8	5	2	3	2	2	2	2	6	4	3	3	1	999
M	1	4	9	5	8	9	4	1	1	1	2	2	3	4	4	6	4	999	999
J	0	5	7	8	12	9	3	2	2	2	2	2	4	4	6	5	2	999	999
J	1	2	4	7	6	4	2	2	3	2	2	4	2	4	4	4	2	999	999
A	1	2	6	4	7	6	2	1	3	2	2	4	4	5	4	1	1	999	999
S	0	2	3	8	15	6	2	2	3	2	2	3	2	5	2	3	3	2	999
O	999	3	3	6	6	7	3	1	2	1	2	2	4	5	3	3	3	1	0
N	999	999	3	6	7	5	4	2	1	1	1	2	5	5	4	2	4	3	1
D	999	999	6	4	6	8	5	2	2	1	2	2	3	2	4	4	2	3	1
1991:																			
J	999	999	7	7	8	9	4	2	2	1	1	3	4	4	5	3	2	2	1
F	999	999	9	12	12	11	8	3	2	1	1	2	2	5	7	5	6	3	1
M	999	5	6	7	9	11	6	3	1	1	1	2	2	2	6	4	3	2	1
A	1	4	8	14	14	7	5	2	2	1	1	2	2	5	7	4	2	2	999
M	0	4	13	18	14	10	5	2	2	1	1	1	3	5	3	3	2	999	999
J	1	3	10	9	13	9	4	2	2	2	1	3	5	5	6	4	3	999	999
J	1	2	4	6	9	5	2	1	2	2	2	3	5	7	7	4	2	999	999
A	1	3	2	7	10	6	2	2	3	2	2	3	4	6	5	4	4	999	999
S	1	3	4	6	11	5	2	2	4	3	3	4	3	4	4	2	3	1	999
O	999	3	3	7	13	9	3	2	2	4	4	3	5	3	4	5	4	1	1
N	999	999	2	4	9	8	3	2	2	2	3	4	4	5	4	2	5	1	1
D	999	999	4	10	9	11	3	2	2	1	2	2	3	4	6	6	5	3	1
1992:																			
J	999	999	5	6	8	14	5	2	1	1	2	2	2	3	4	3	3	2	0

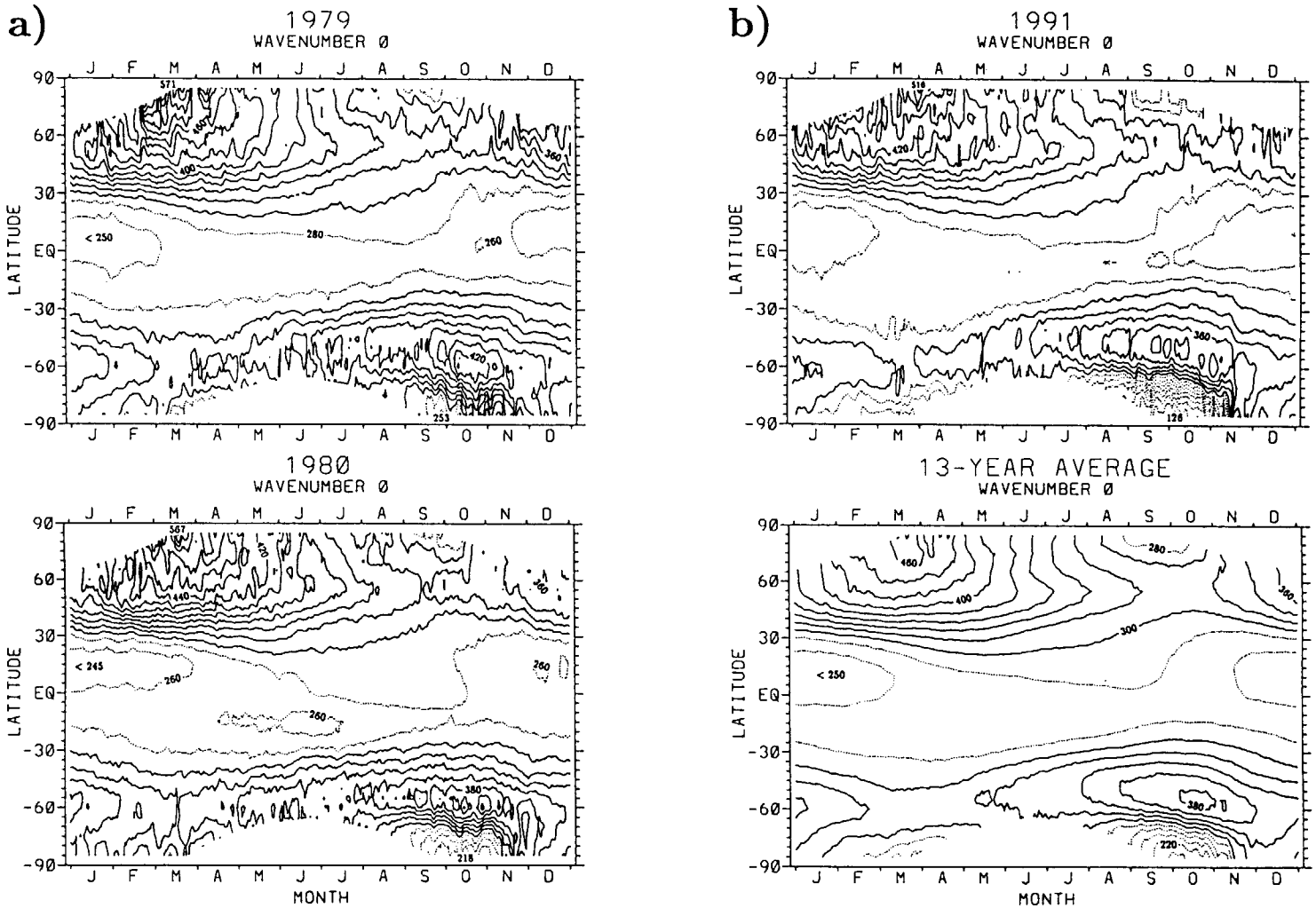


Figure 5. (a)–(b): Zonal mean TOMS total ozone (units DU) plotted latitude vs. time (months indicated). No temporal filtering employed. Dashed (solid) contours begin at 280 (300) and decrement (increment) by 20. (a): Years 1979 (top) and 1980 (bottom). (b): Year 1991 (top) and 13-year (1979–1991) average (bottom). [13-year means formed by averaging similar days of each year.] (c)–(d): Same as (a) and (b), except for zonal wave 1 RMS amplitudes. For all but 13-year average plot, dashed contours are 20; solid contours begin at 40, incrementing by 20. For 13-year average plot, dashed (solid) contours are 8 (16, 24, 32,...). (e)–(f): Wave 2, with all dashed (solid) contours 15 (30, 45, 60,...). (g)–(h): Wave 3, with all dashed (solid) contours 5 (15, 25, 35,...). (i)–(j): Waves 4–7, with all dashed (solid) contours 10 (20, 30, 40,...).

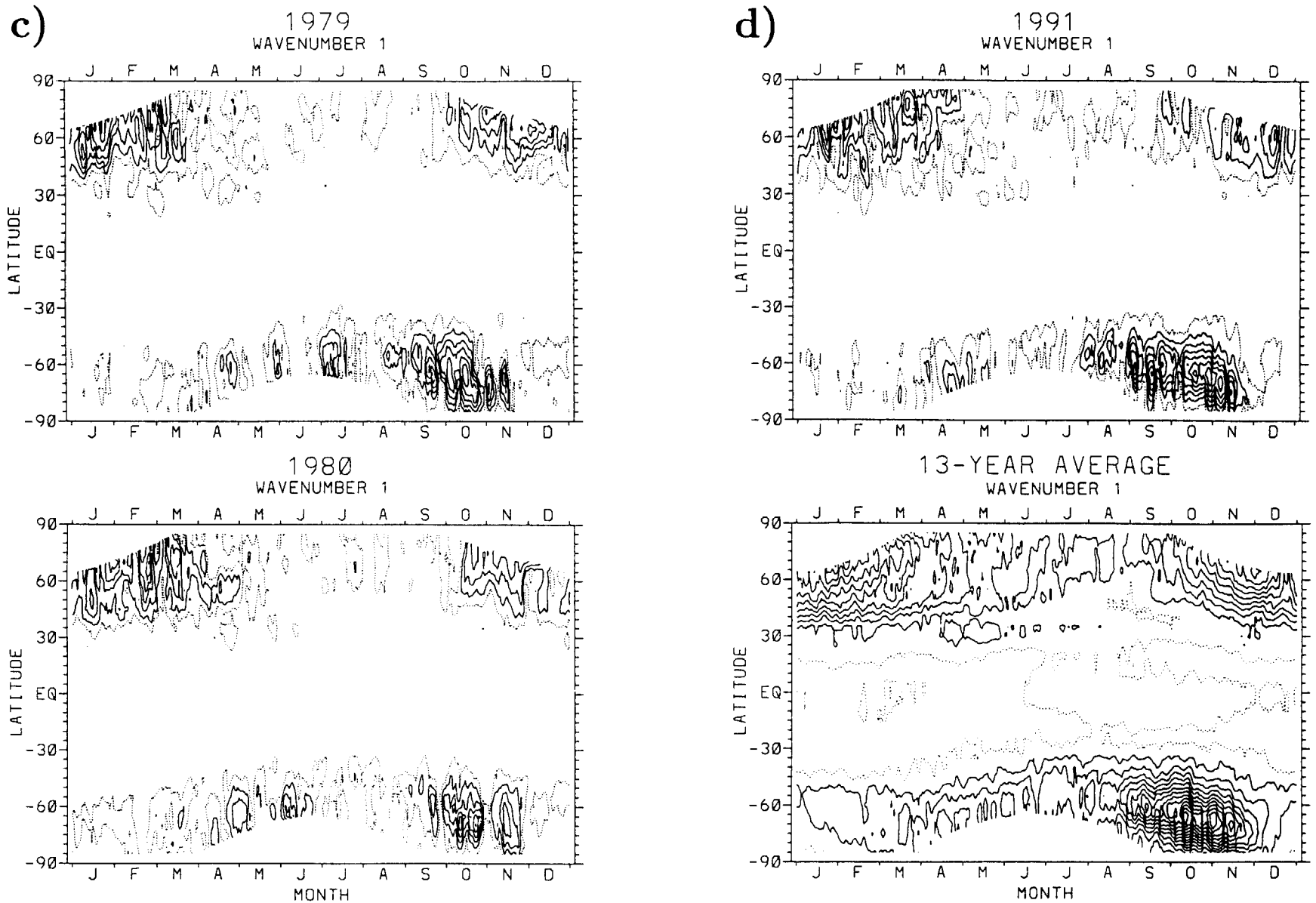


Figure 5. (continued)

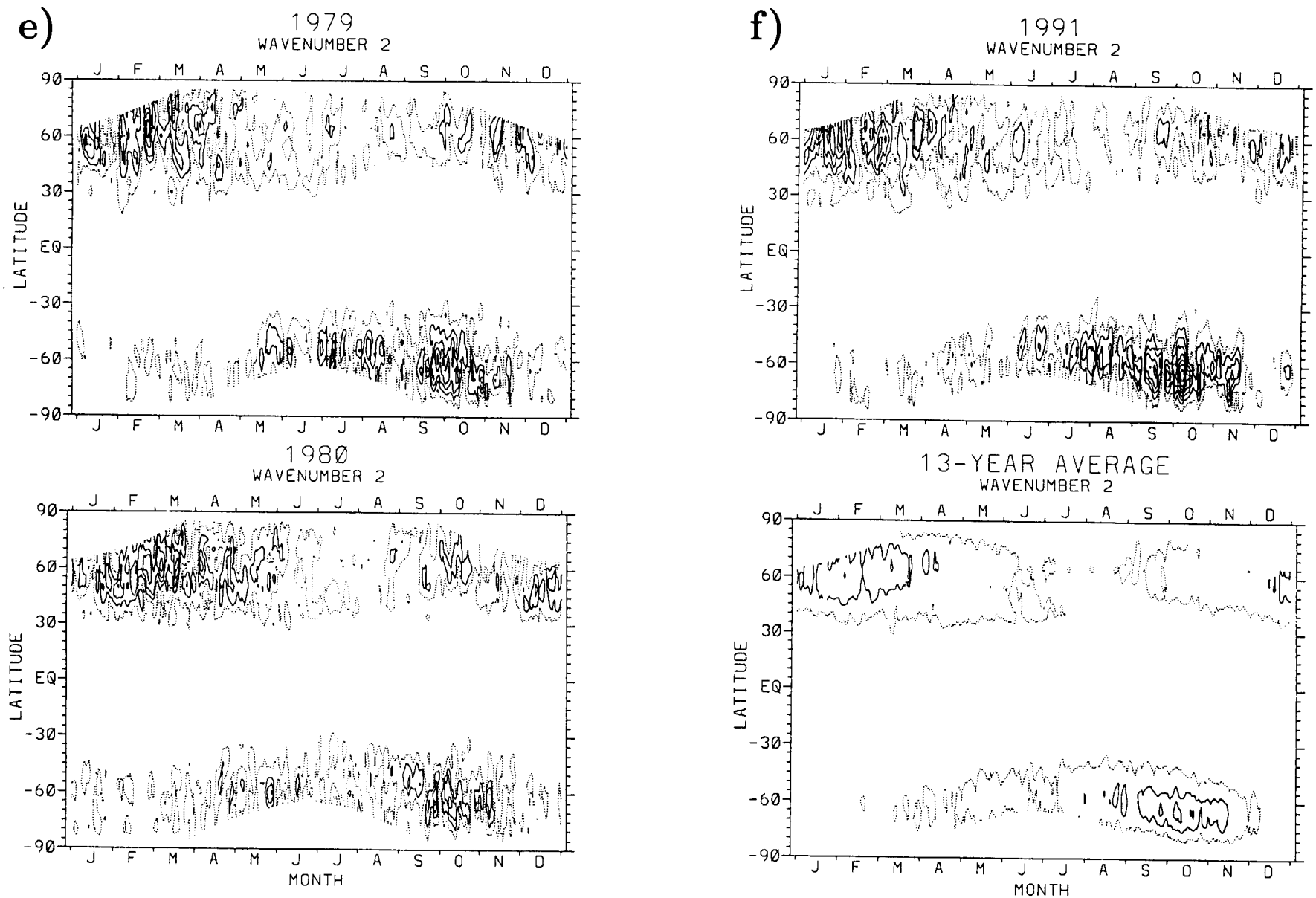


Figure 5. (continued)

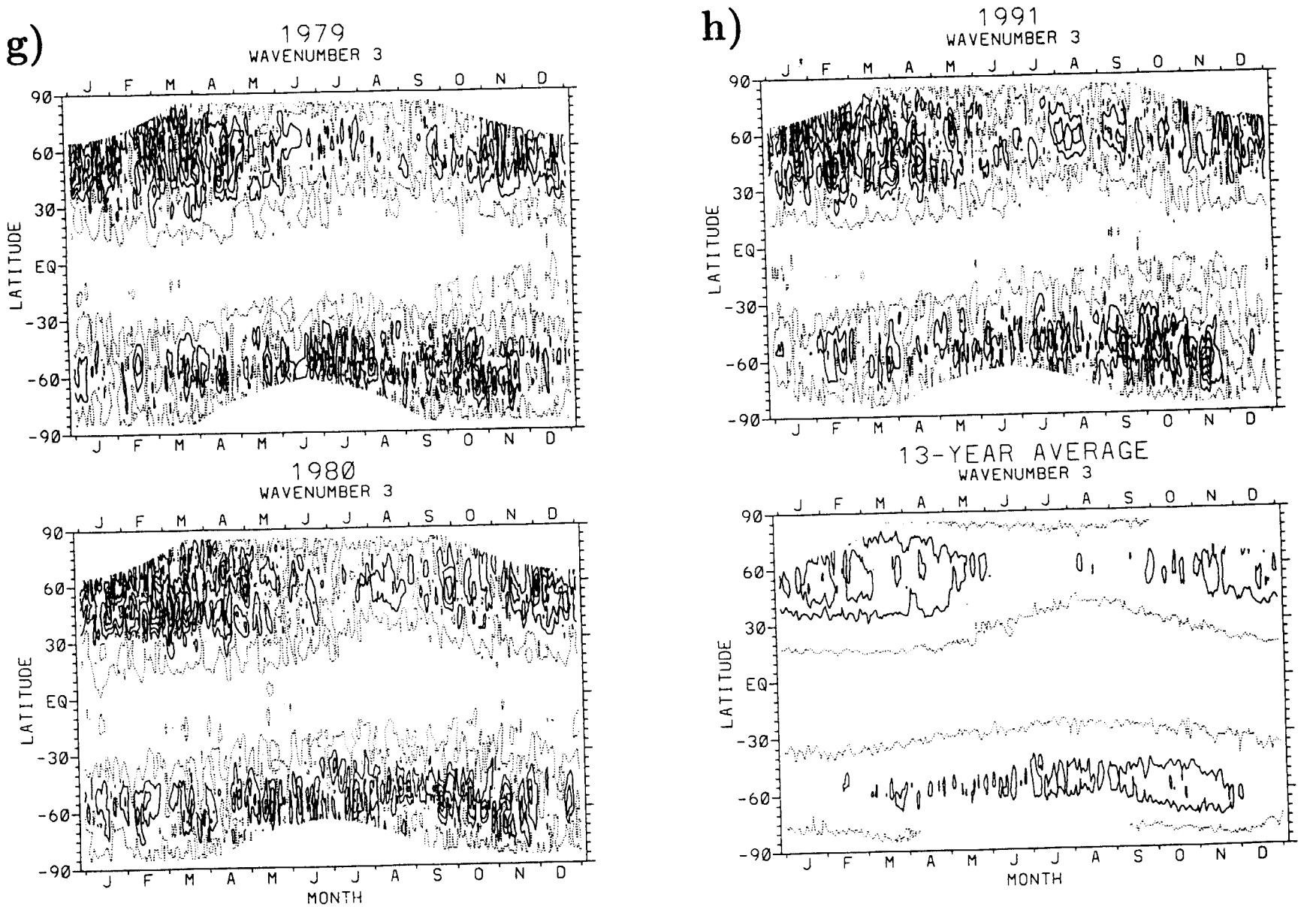


Figure 5. (continued)

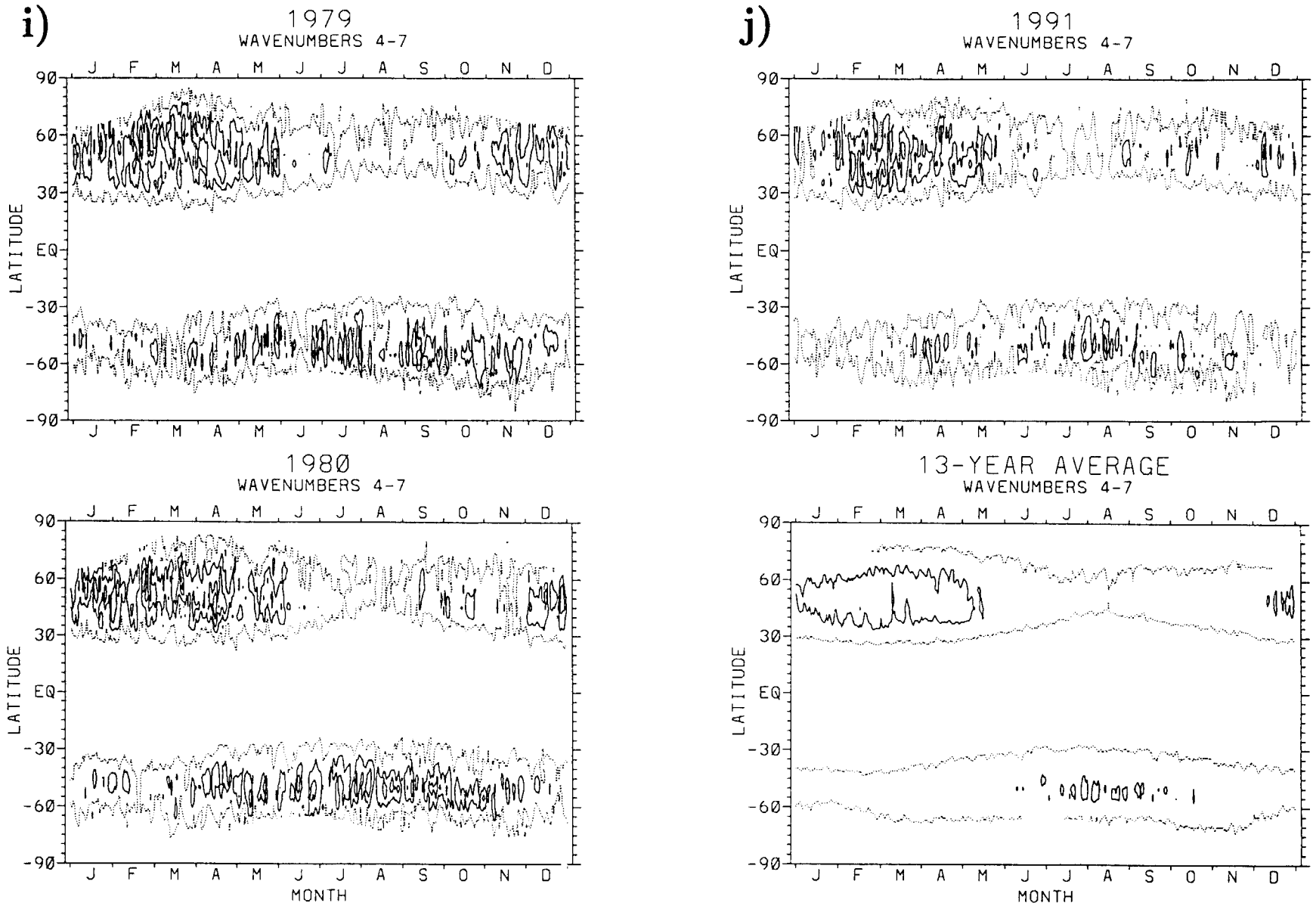


Figure 5. (continued)

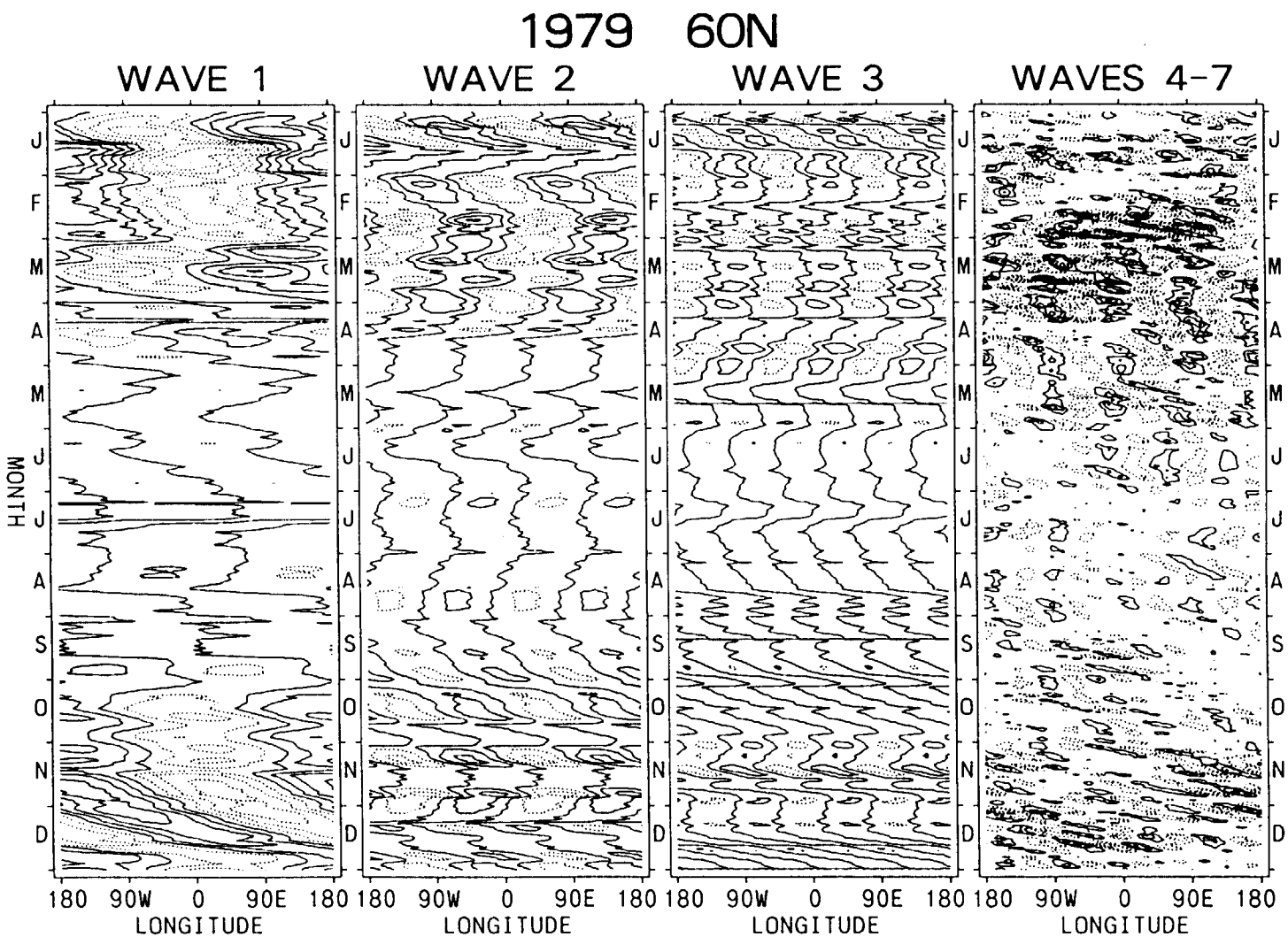


Figure 6. Hovmöller time (months shown) vs. longitude diagrams of TOMS ozone (units DU) at latitudes indicated on each page. Years shown: 1979, 1985, and 1991. No temporal filtering employed. Contour values indicated on each page.

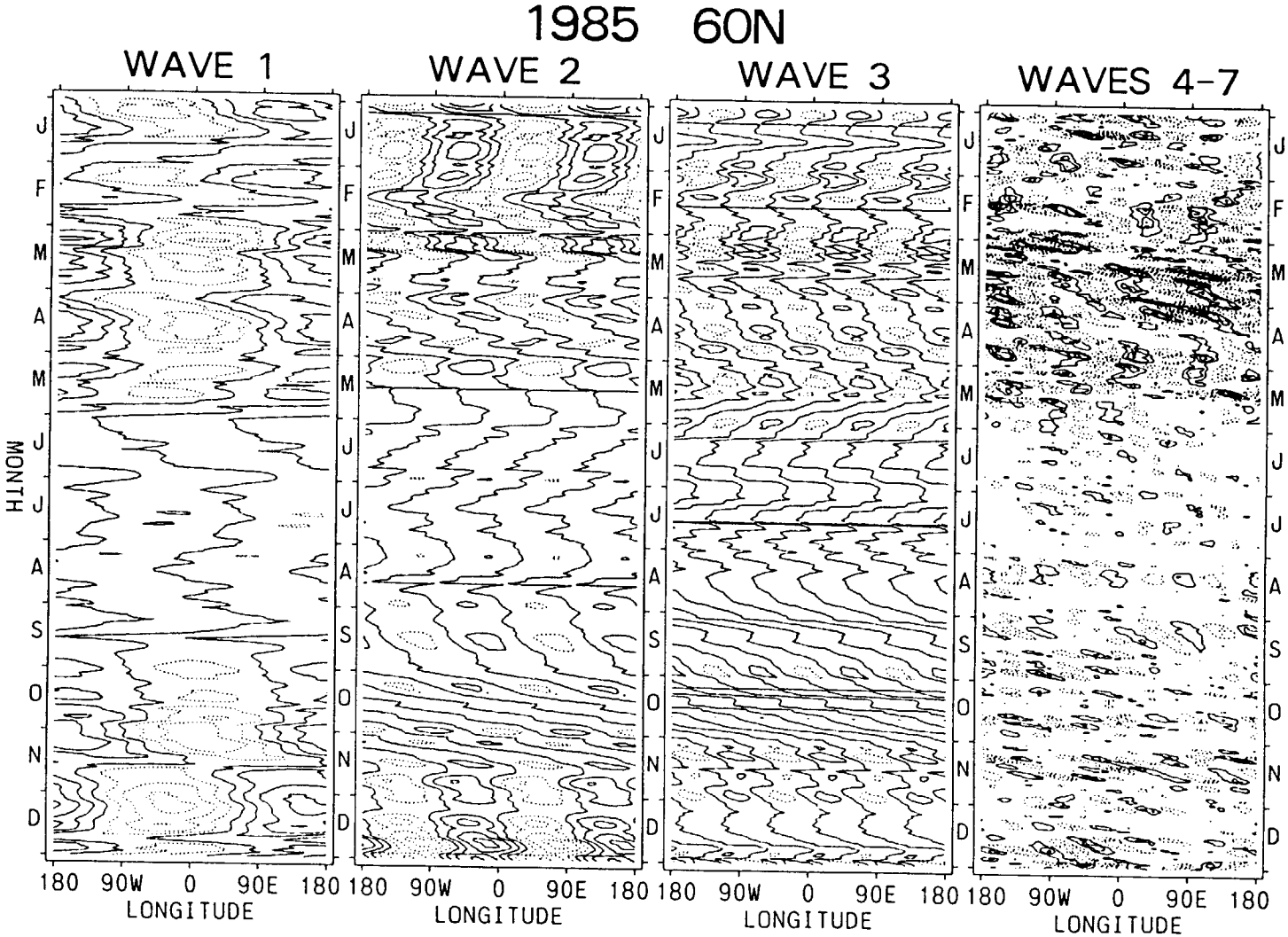


Figure 6. (continued)

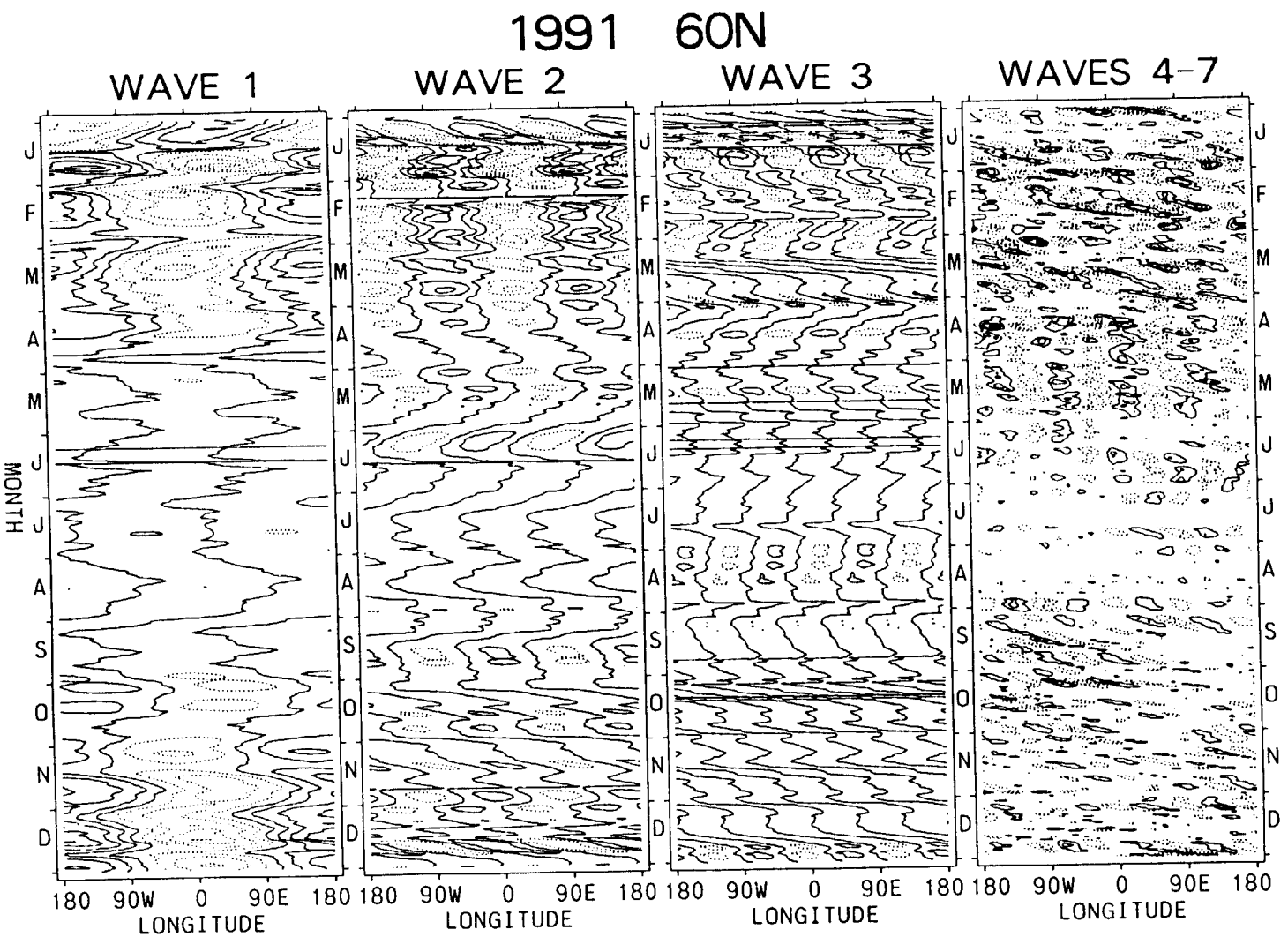


Figure 6. (continued)

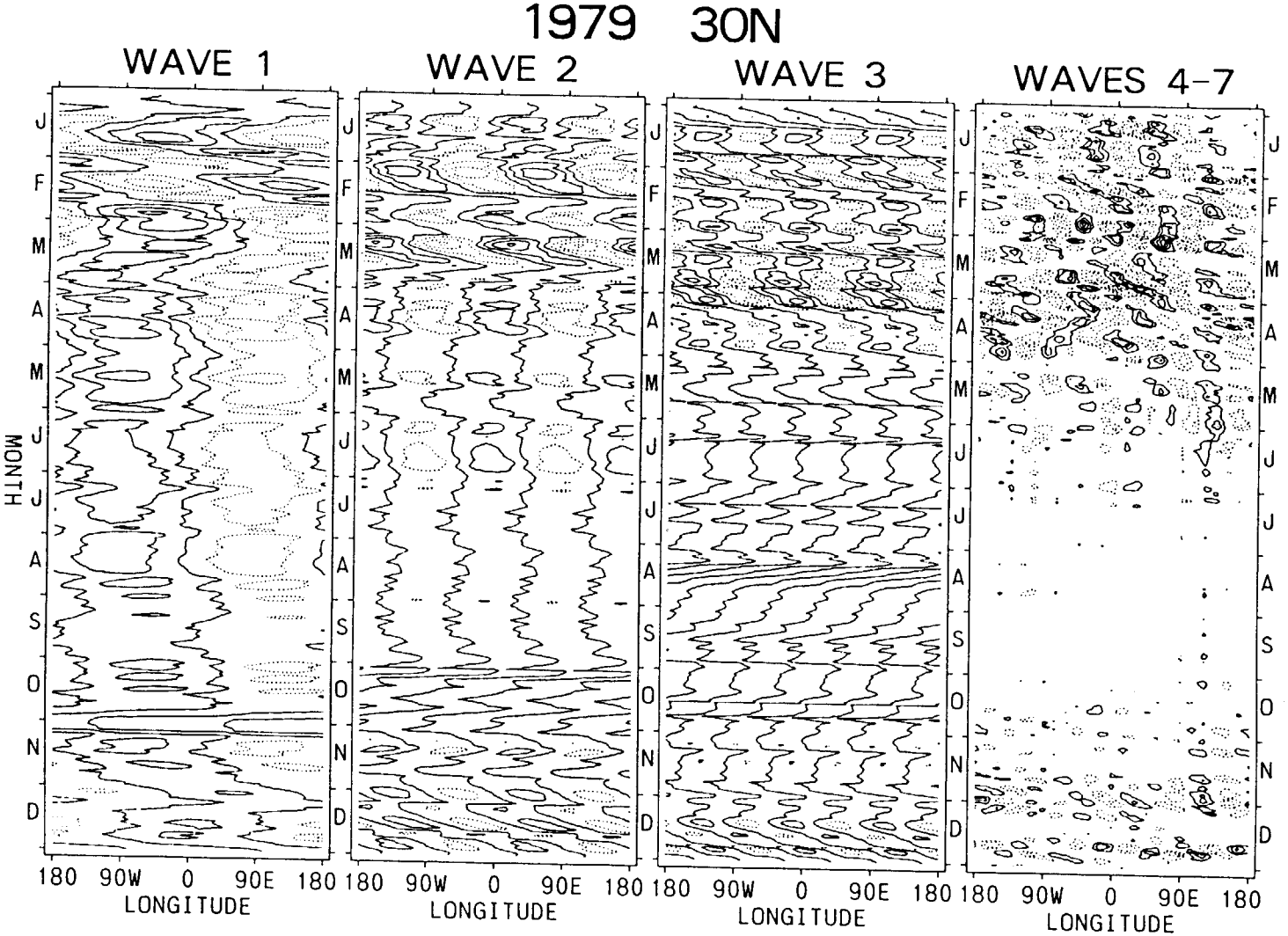


Figure 6. (continued)

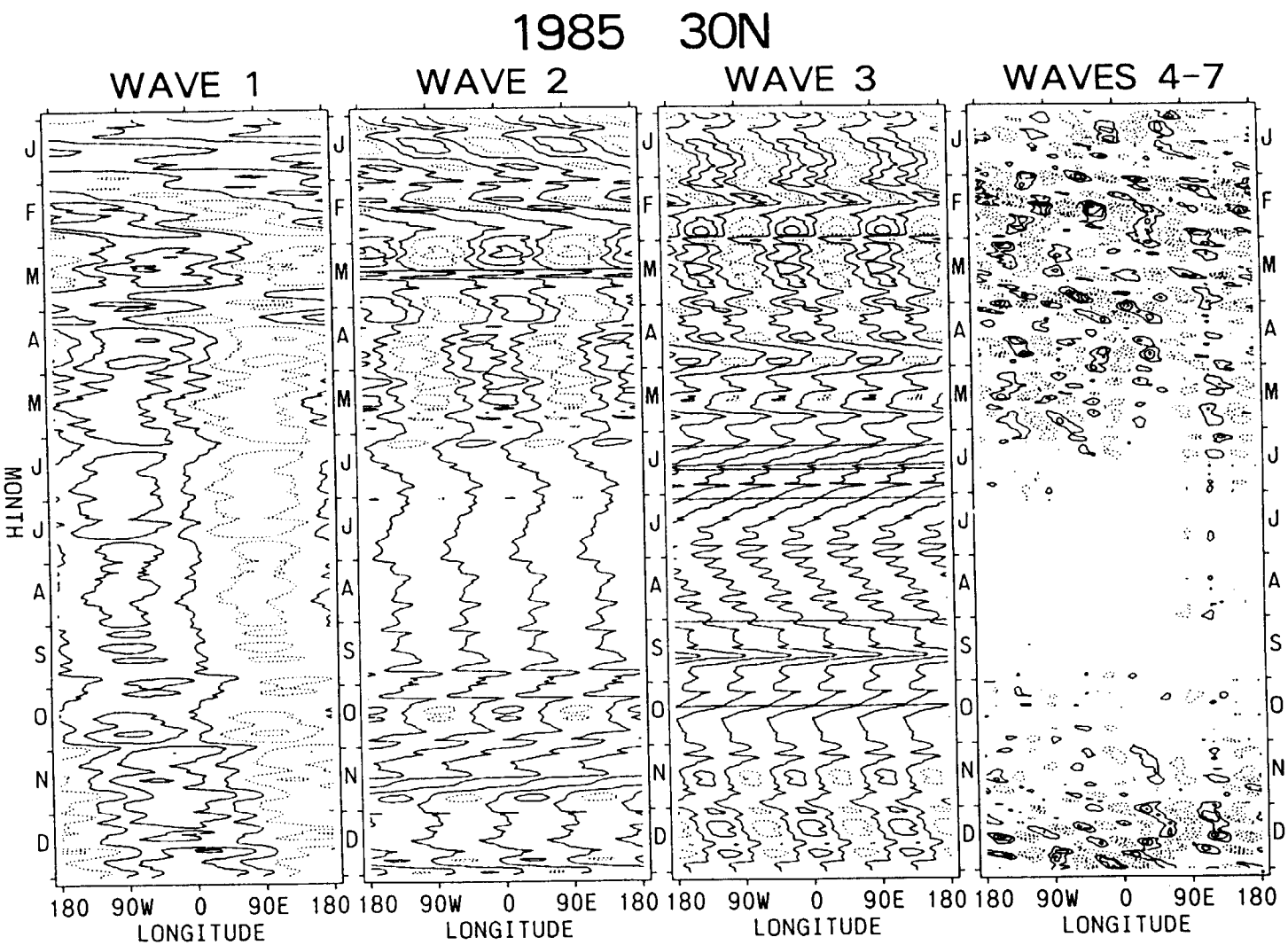


Figure 6. (continued)

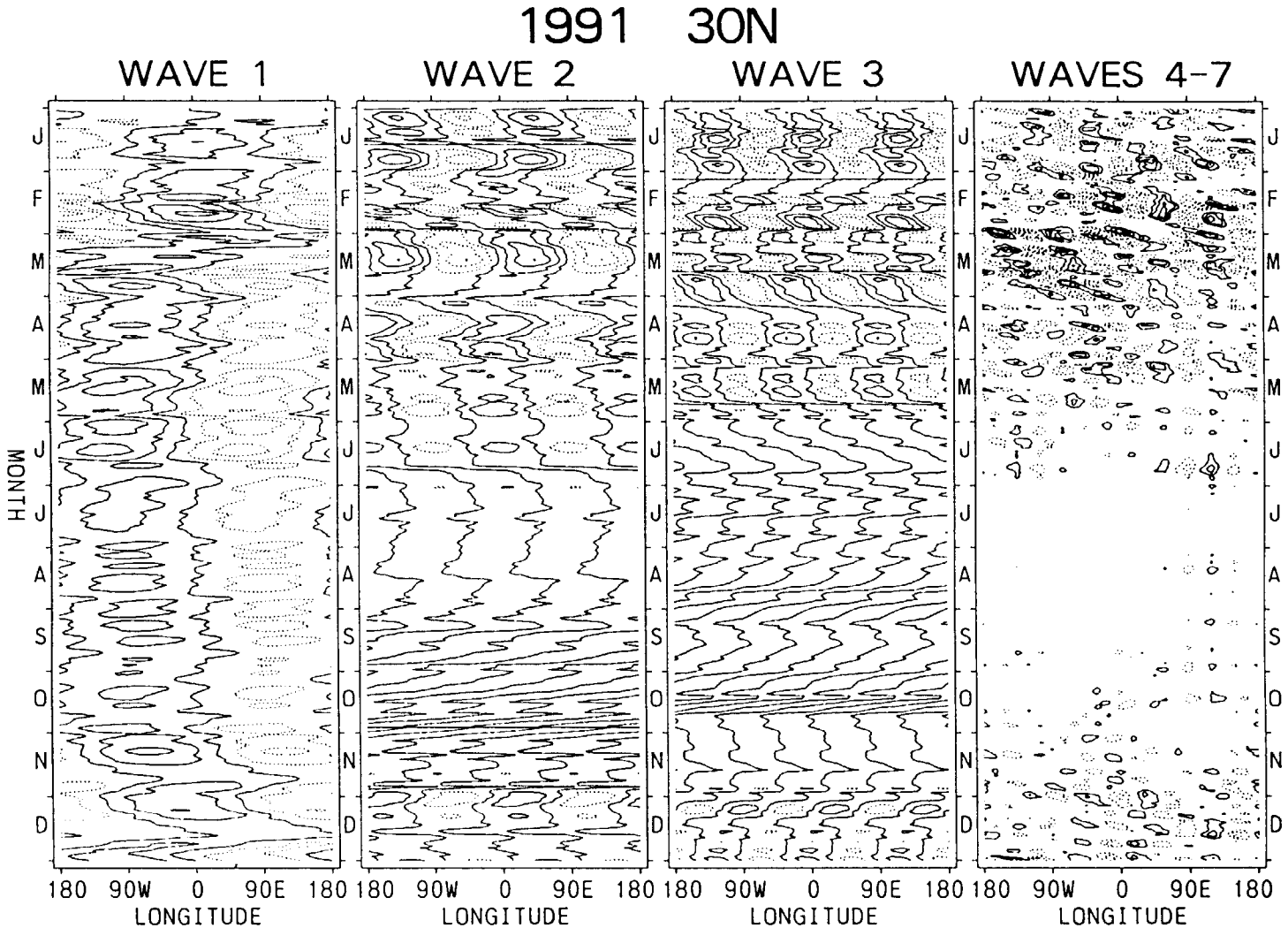


Figure 6. (continued)

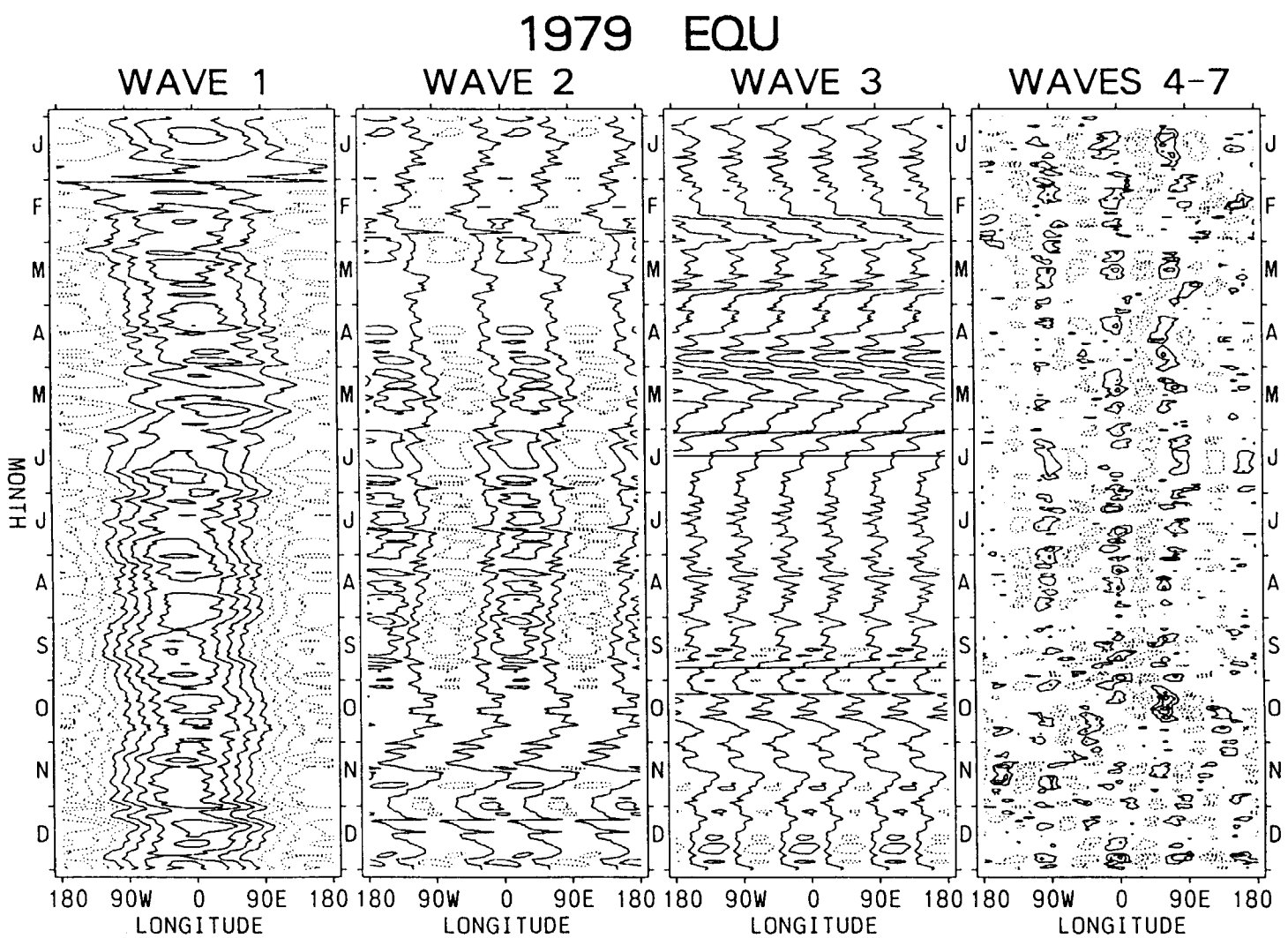


Figure 6. (continued)

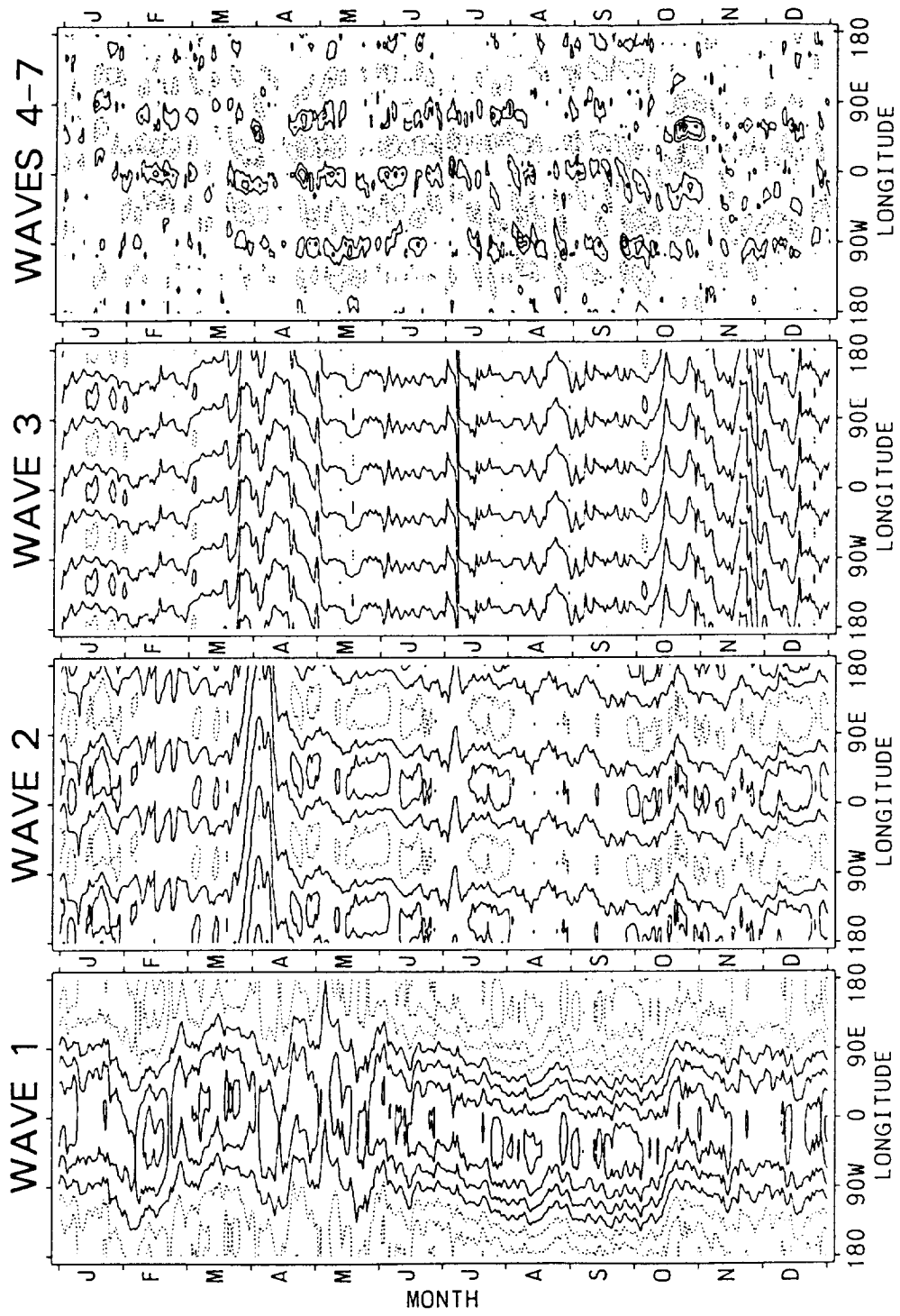


Figure 6. (continued)

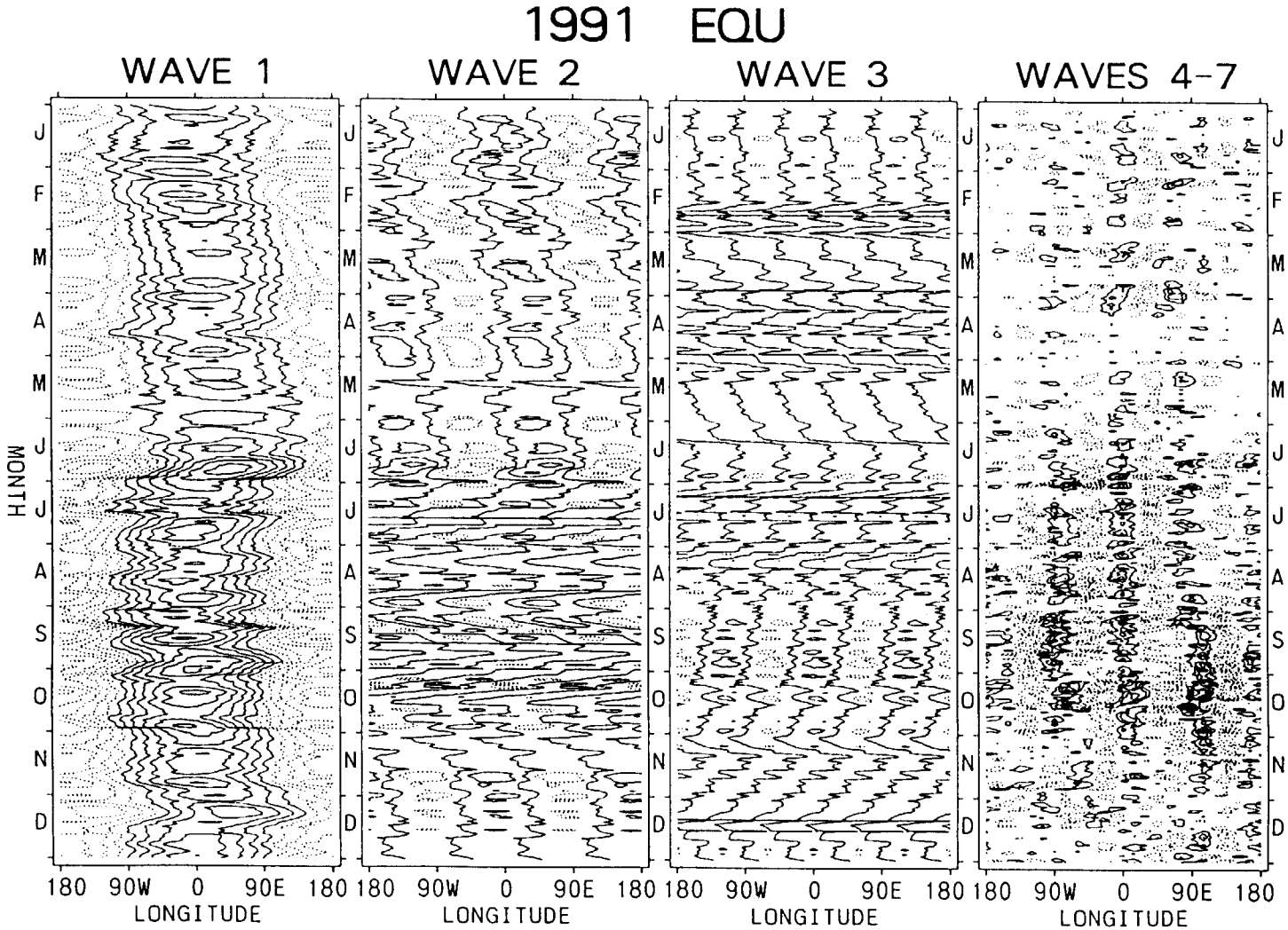


Figure 6. (continued)

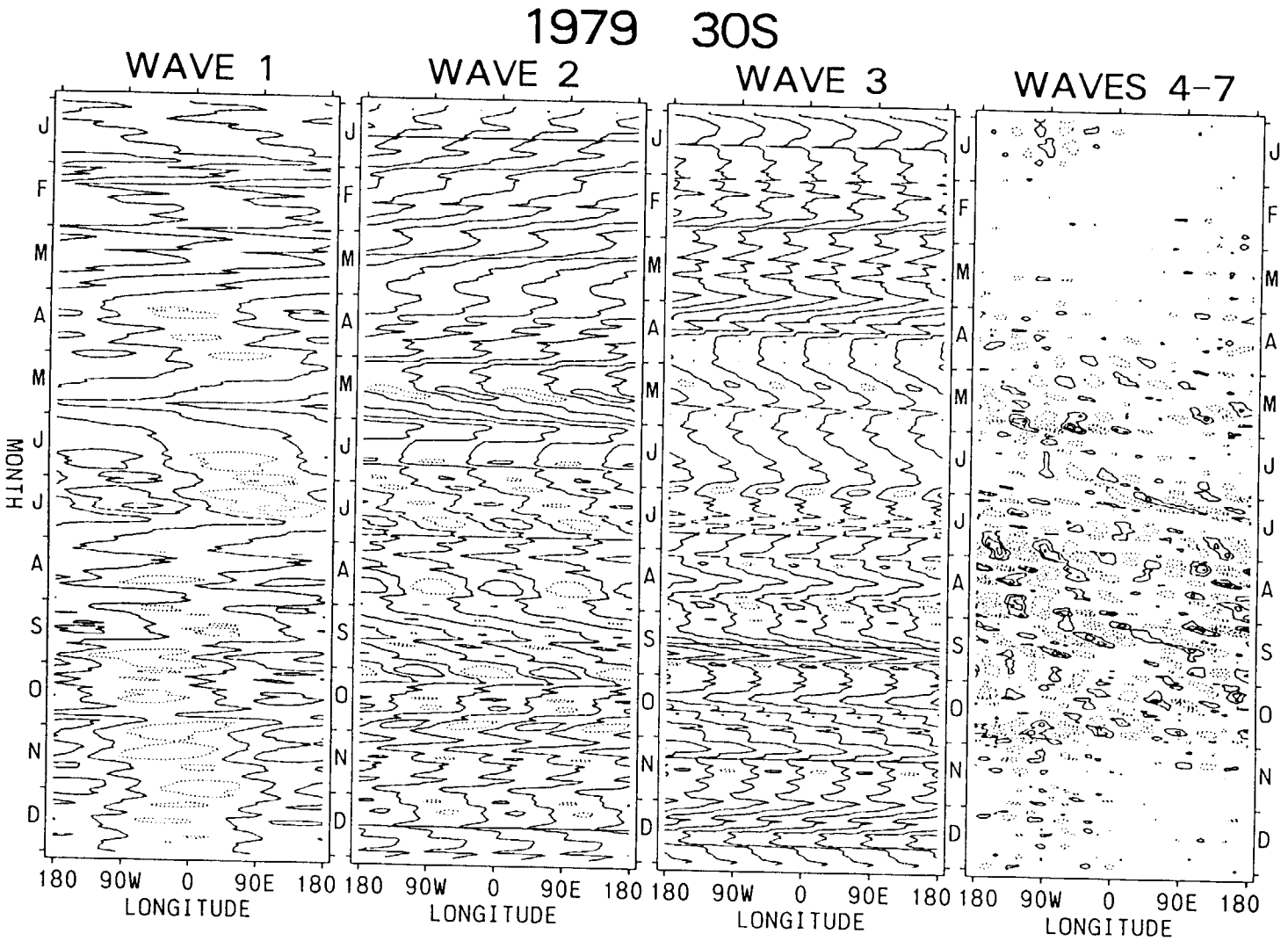


Figure 6. (continued)

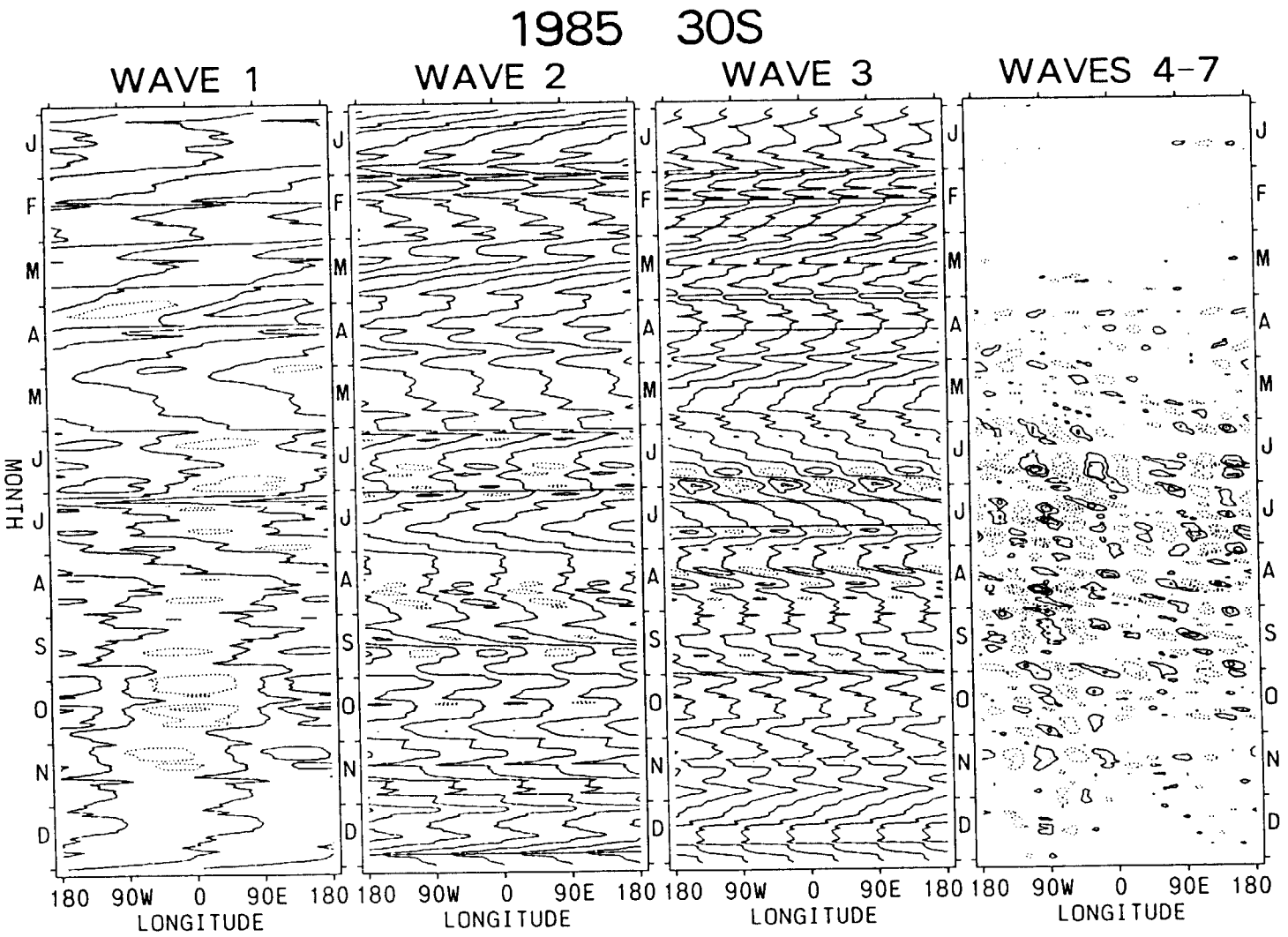


Figure 6. (continued)

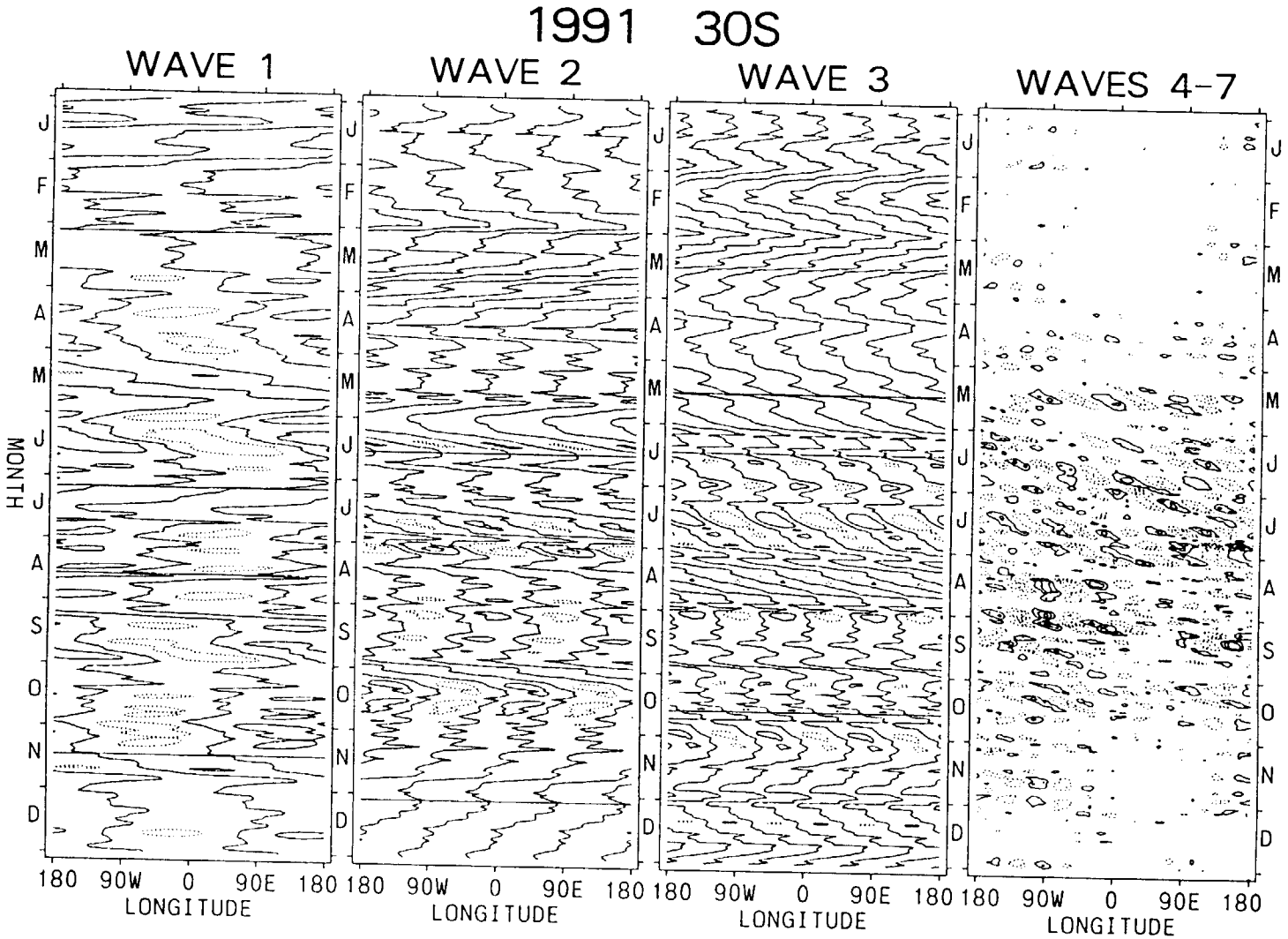


Figure 6. (continued)

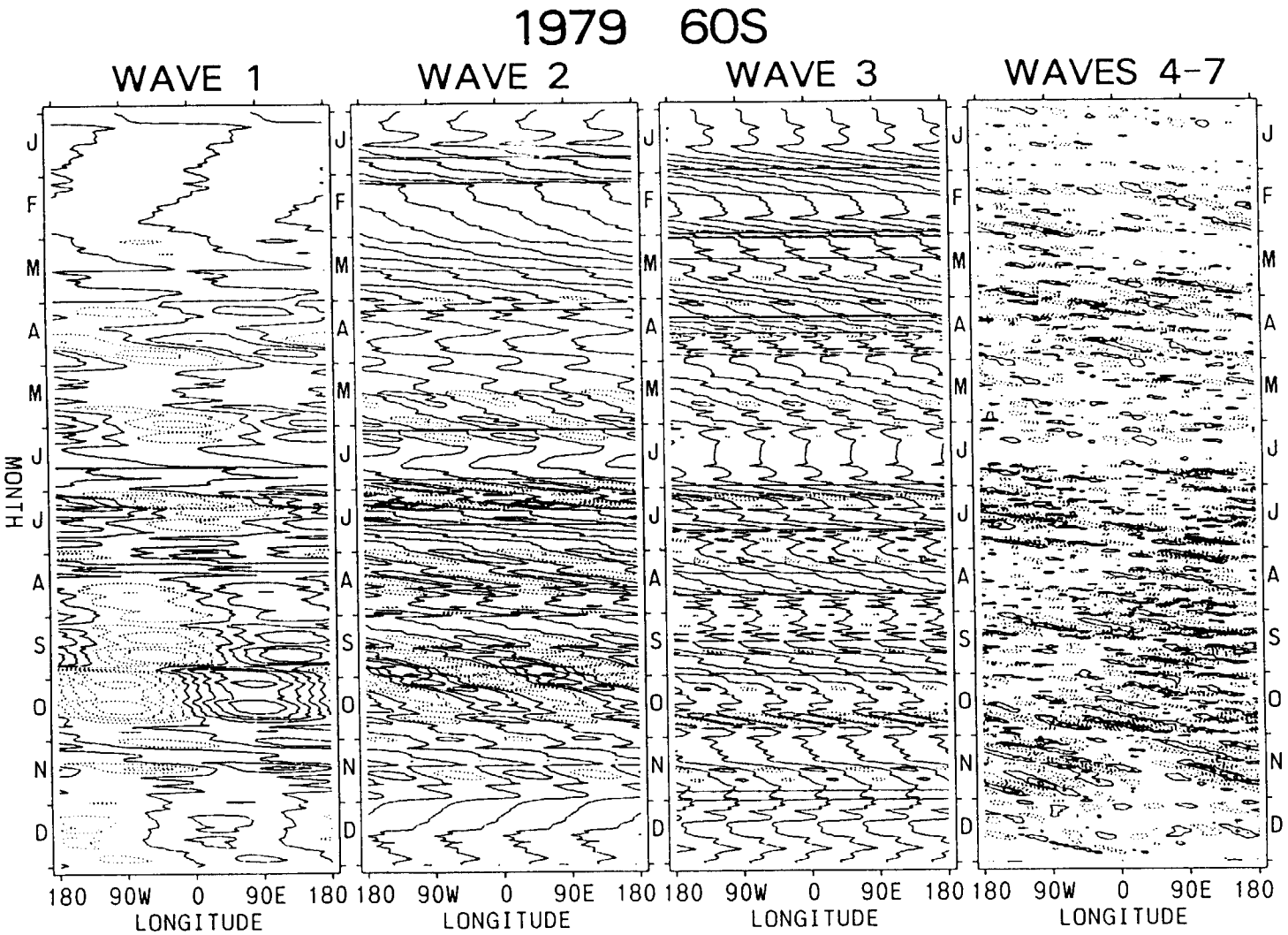


Figure 6. (continued)

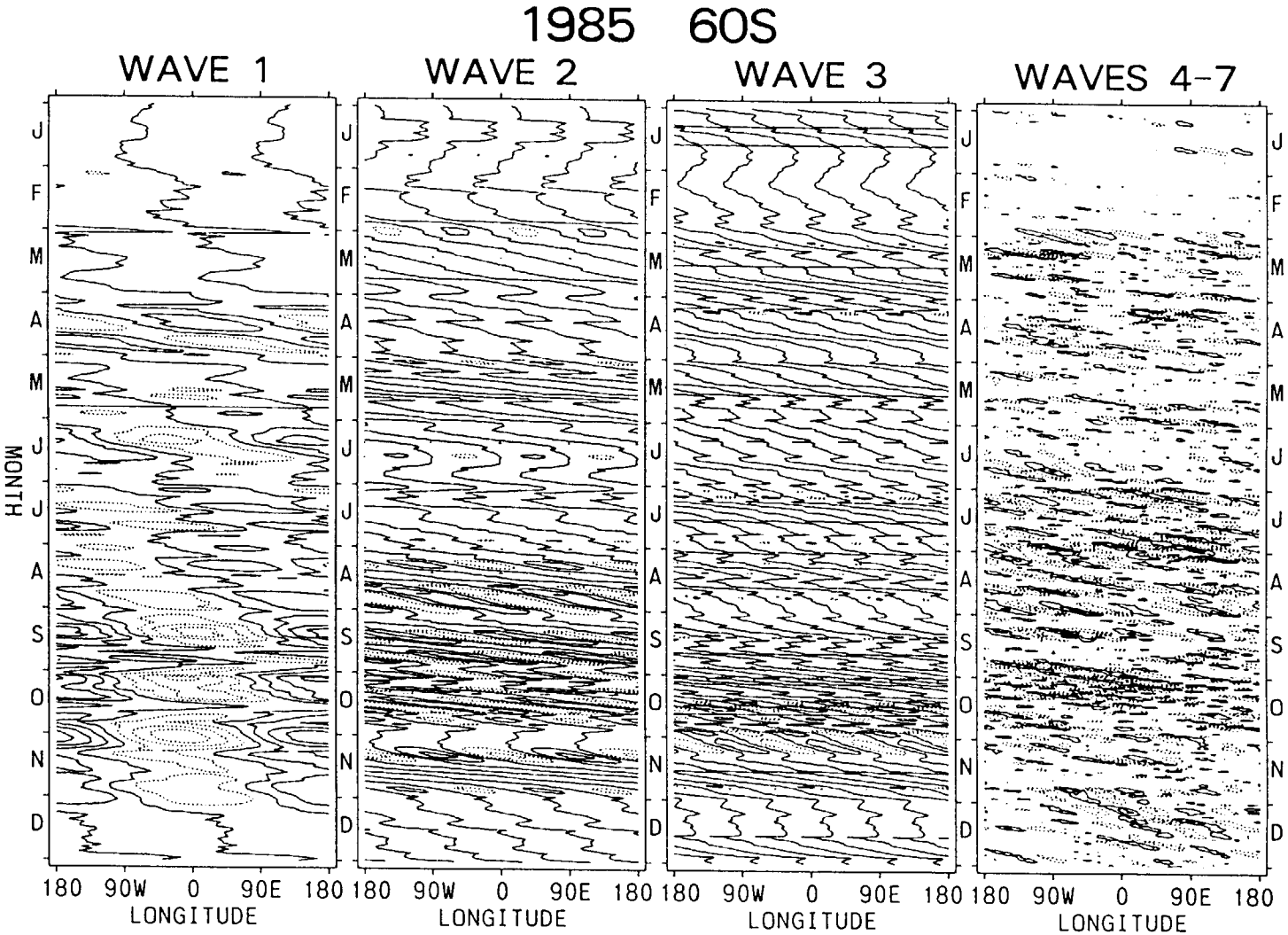


Figure 6. (continued)

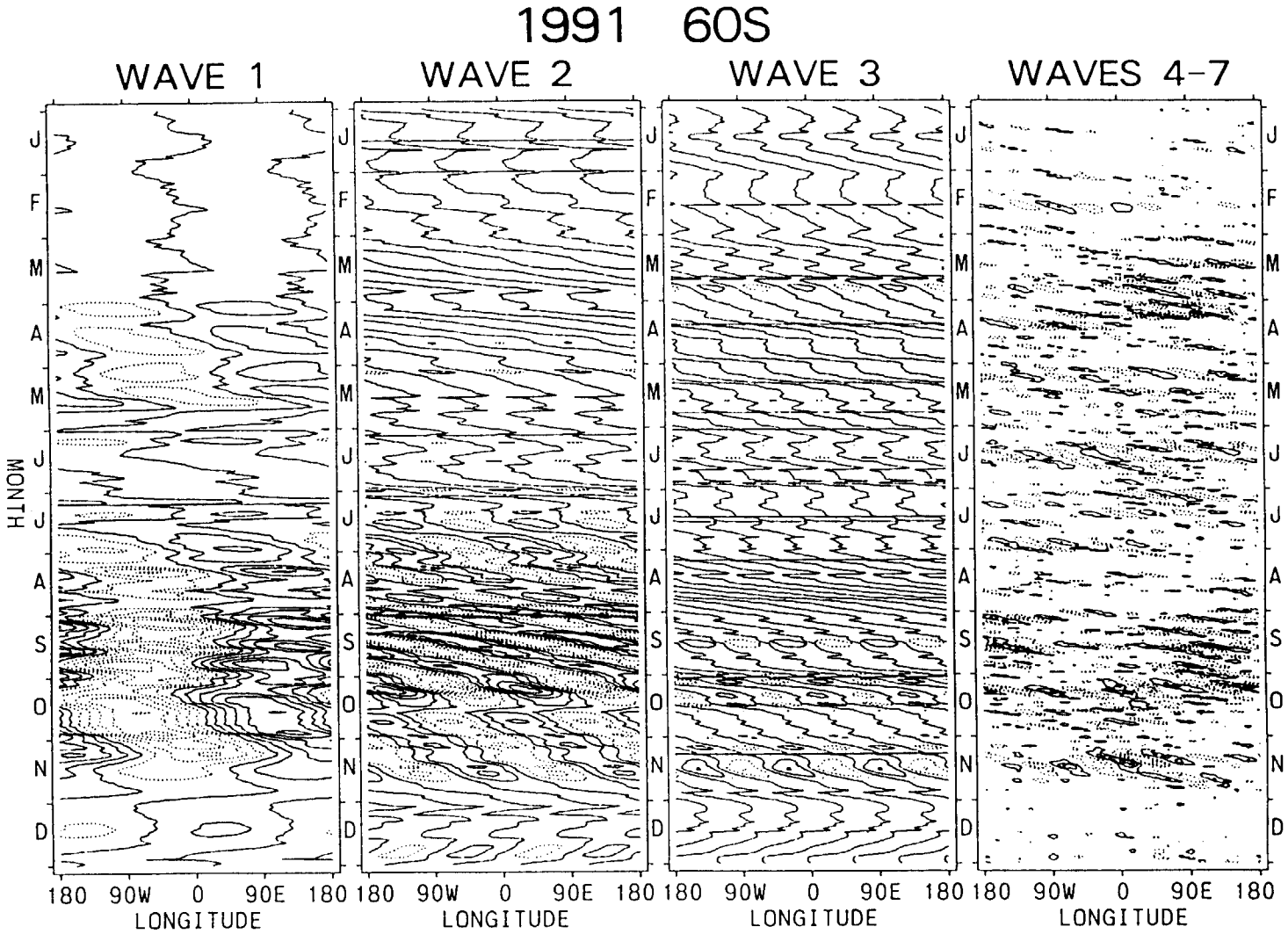


Figure 6. (continued)

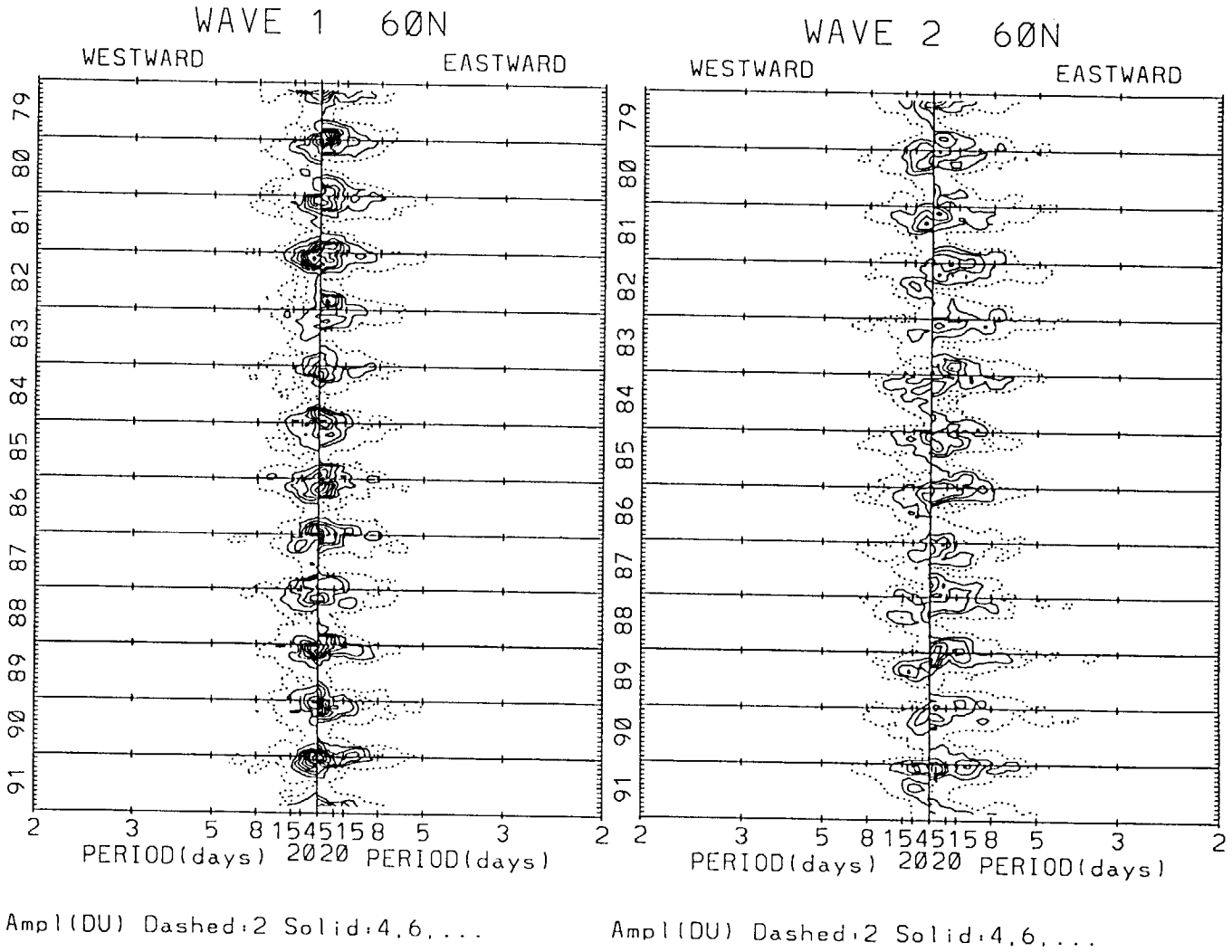


Figure 7. Time vs. frequency (periods in days shown) westward/eastward spectral amplitudes for waves 1, 2, 3, and 4–7 at latitudes 60° S to 60° N (15° increment). Units: DU. A 90-day window using a one month increment was employed. Temporal span: 1 January 1979–31 December 1991. Dashed and solid contour values are indicated under each frame.

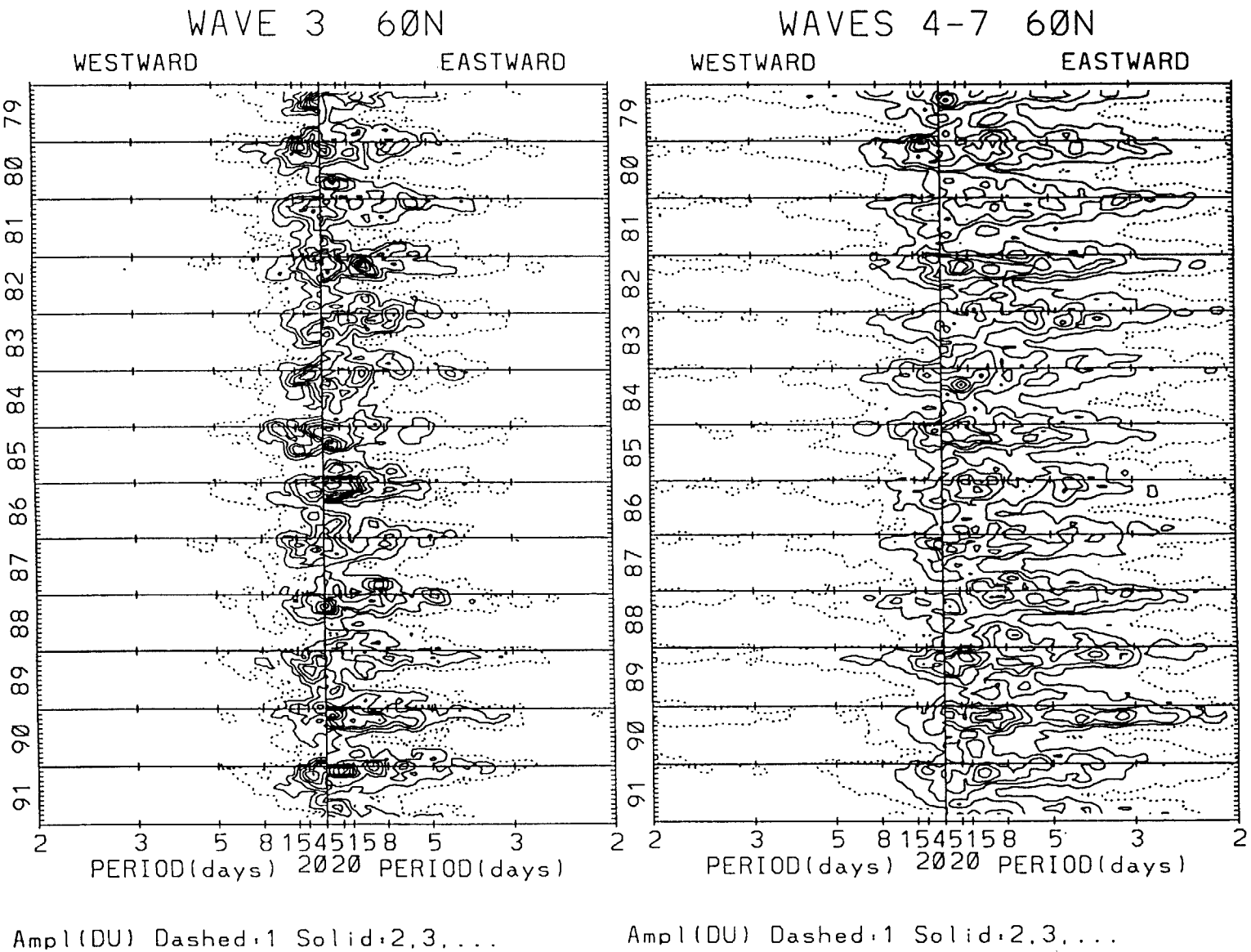


Figure 7. (continued)

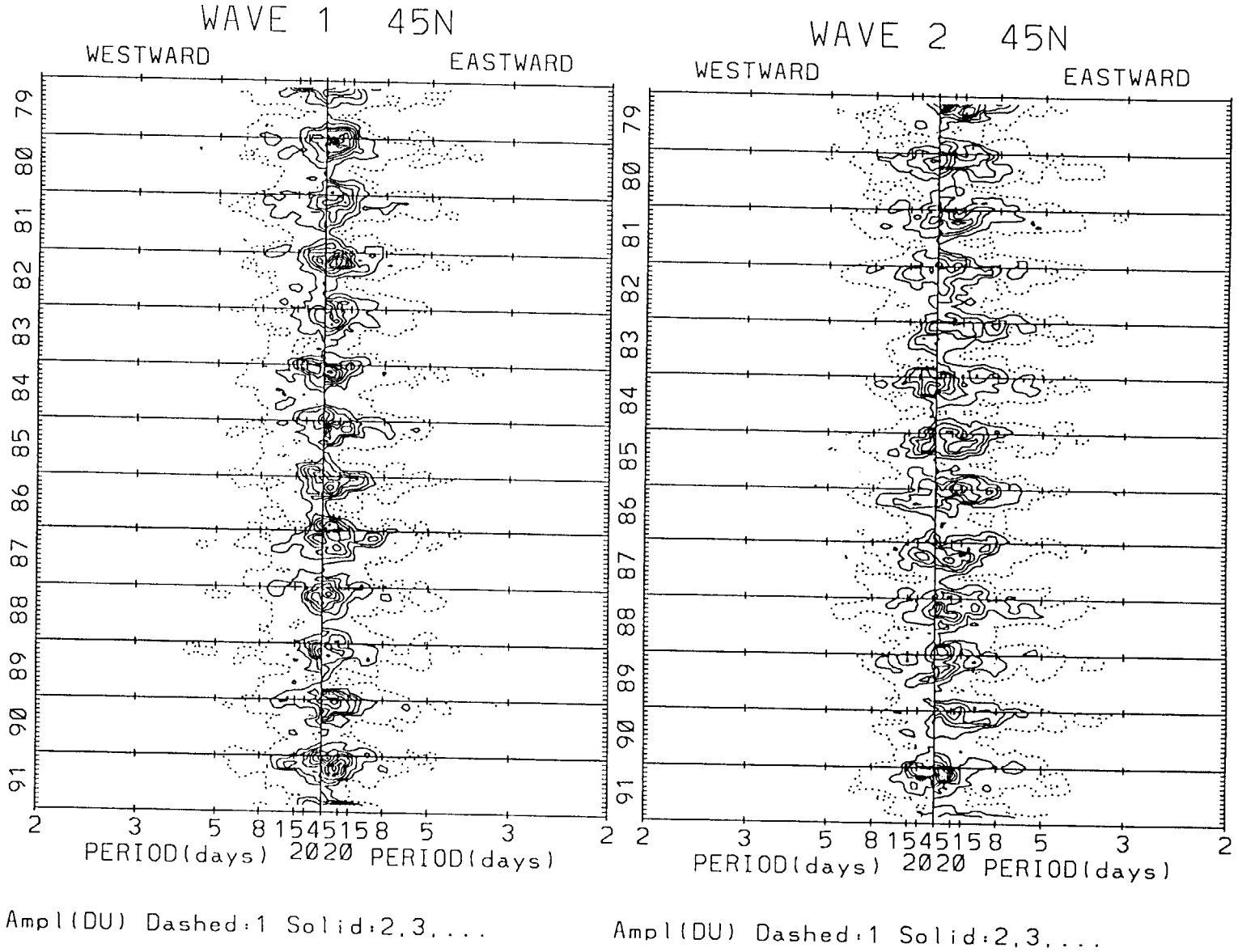


Figure 7. (continued)

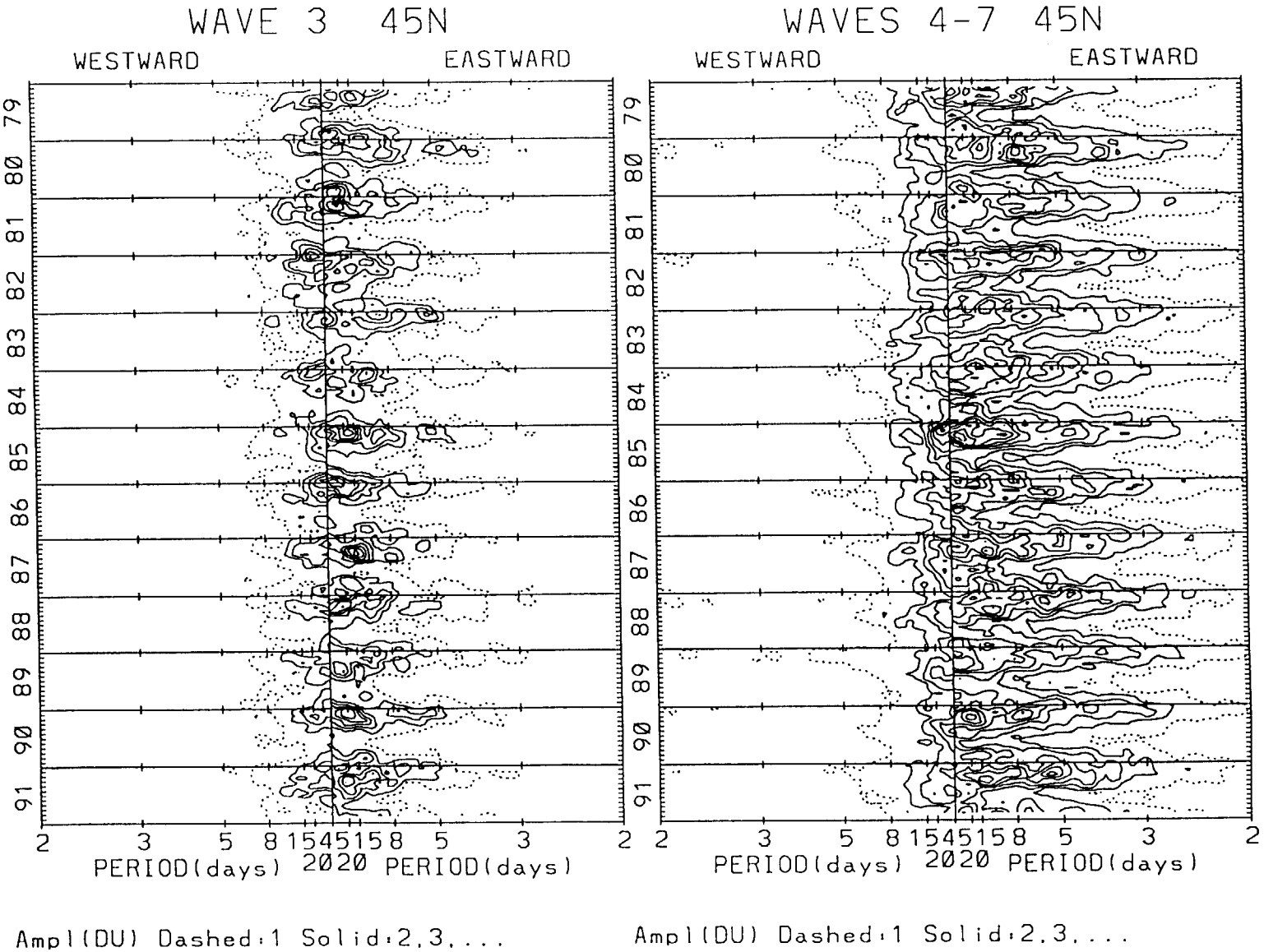


Figure 7. (continued)

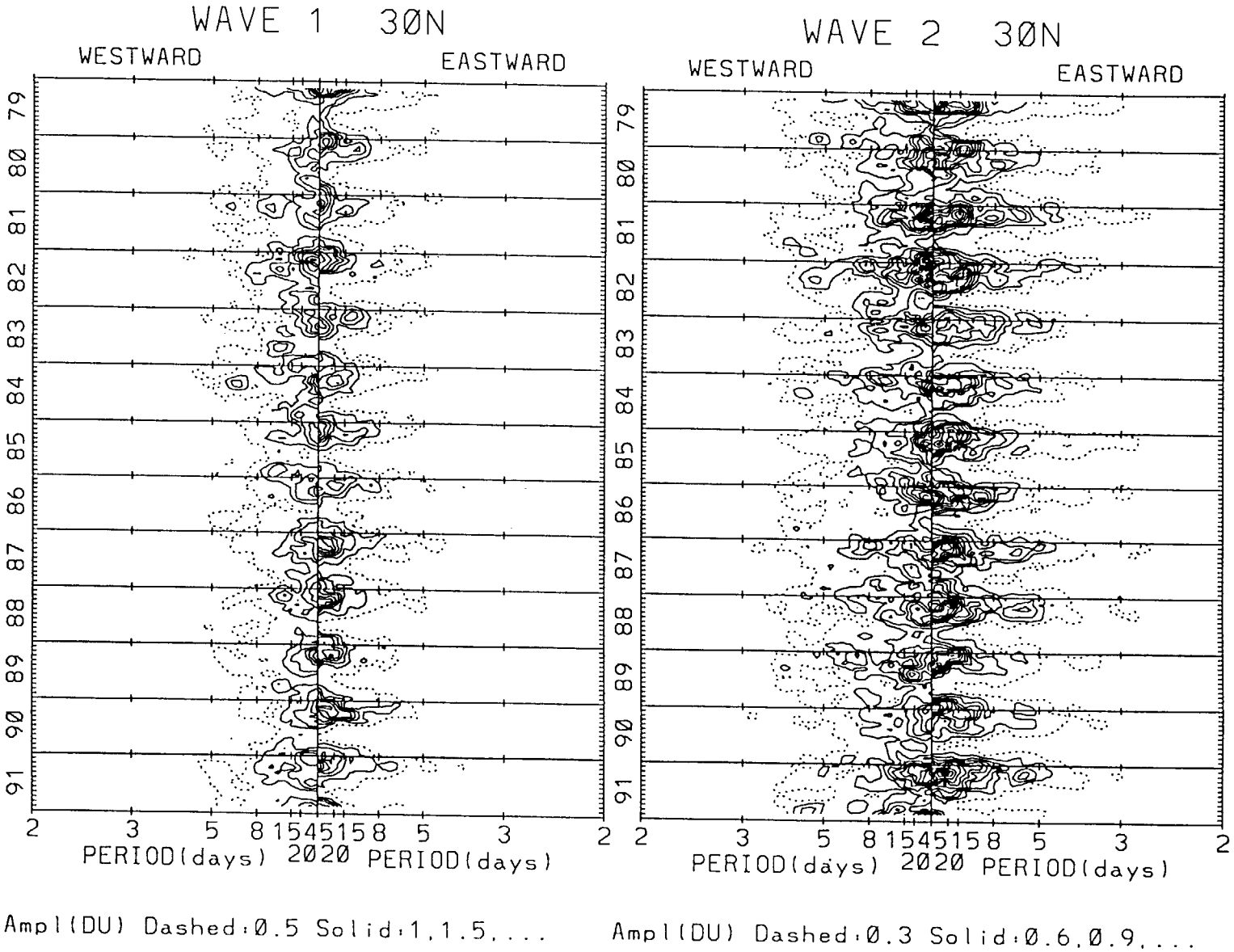


Figure 7. (continued)

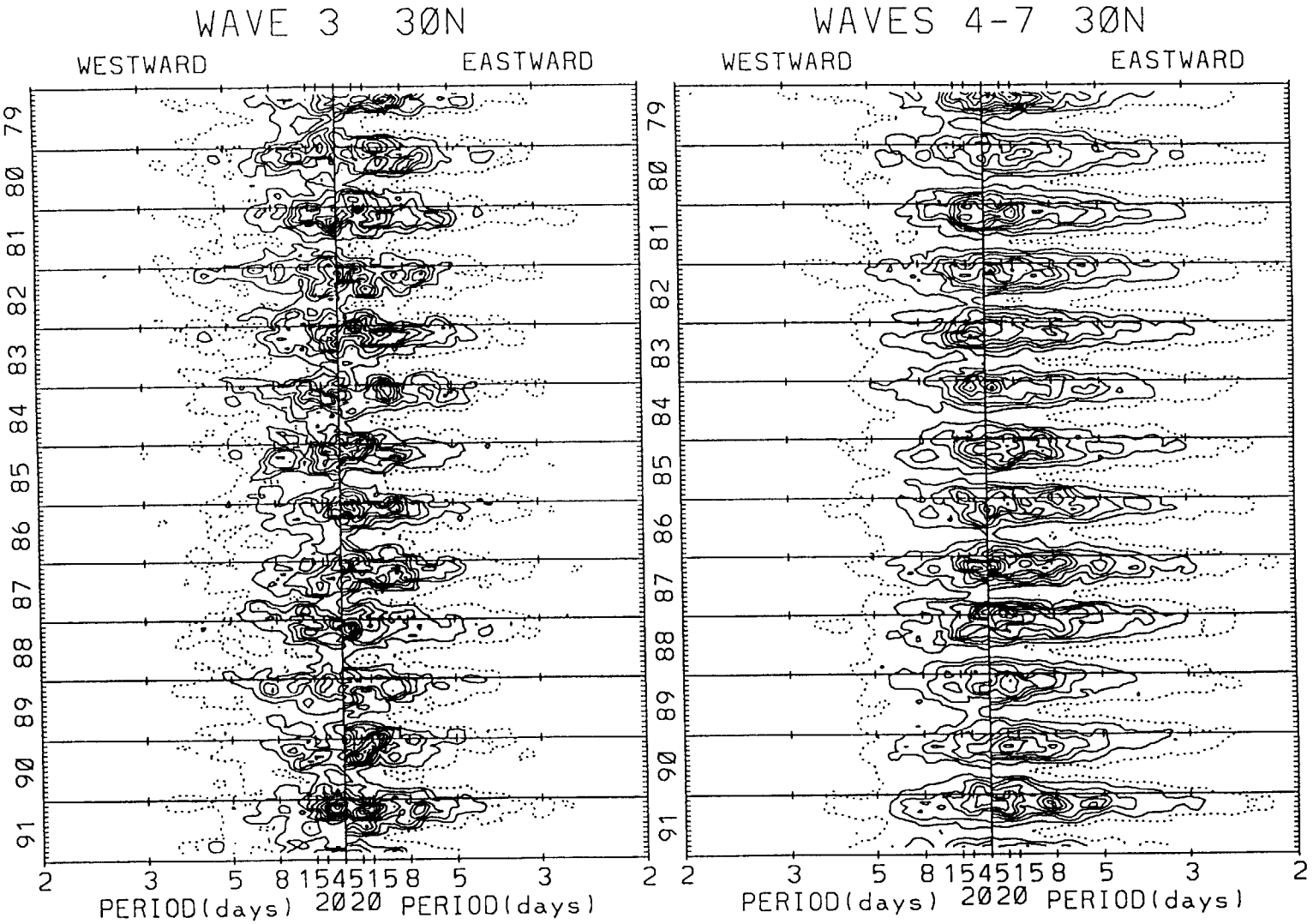


Figure 7. (continued)

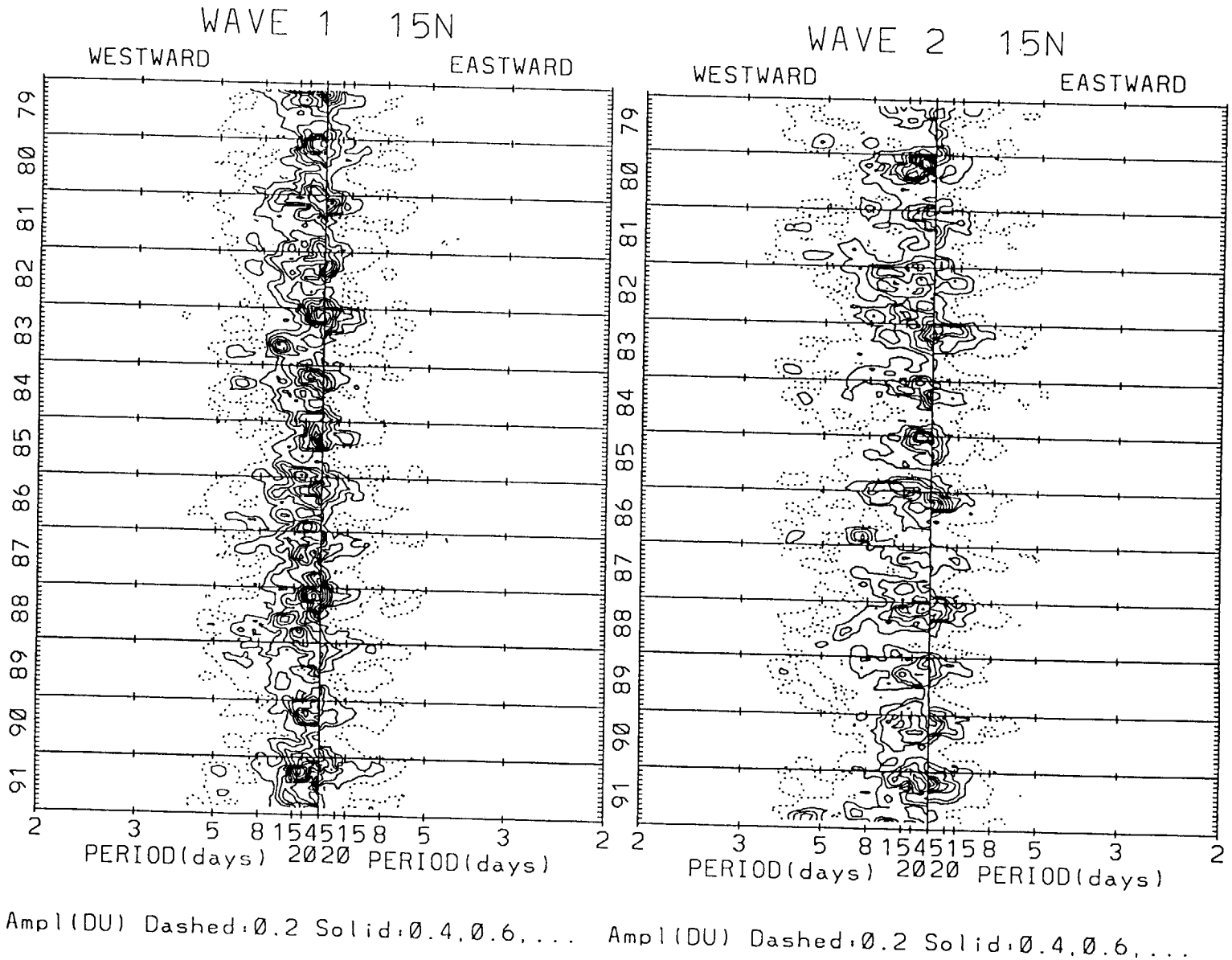
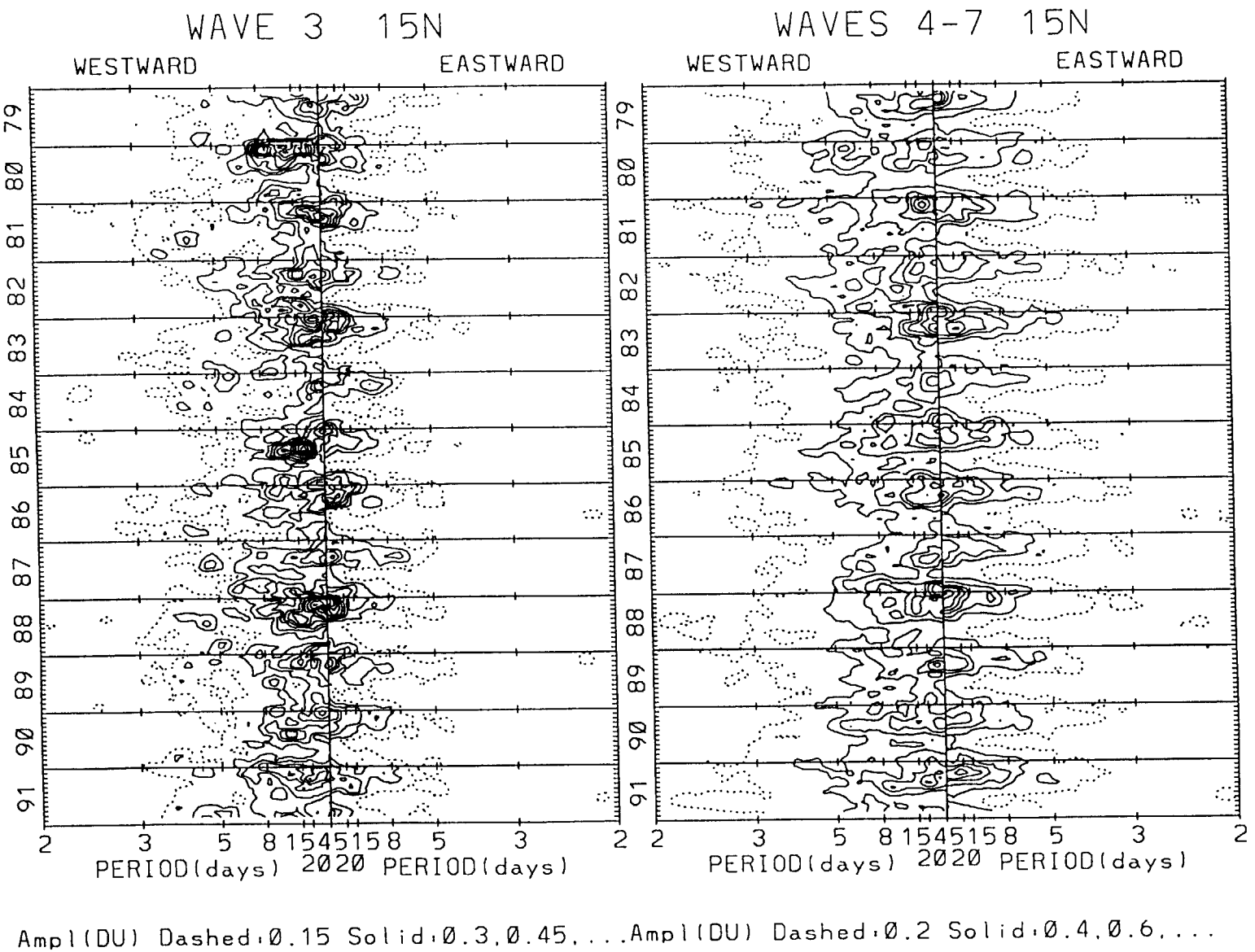


Figure 7. (continued)



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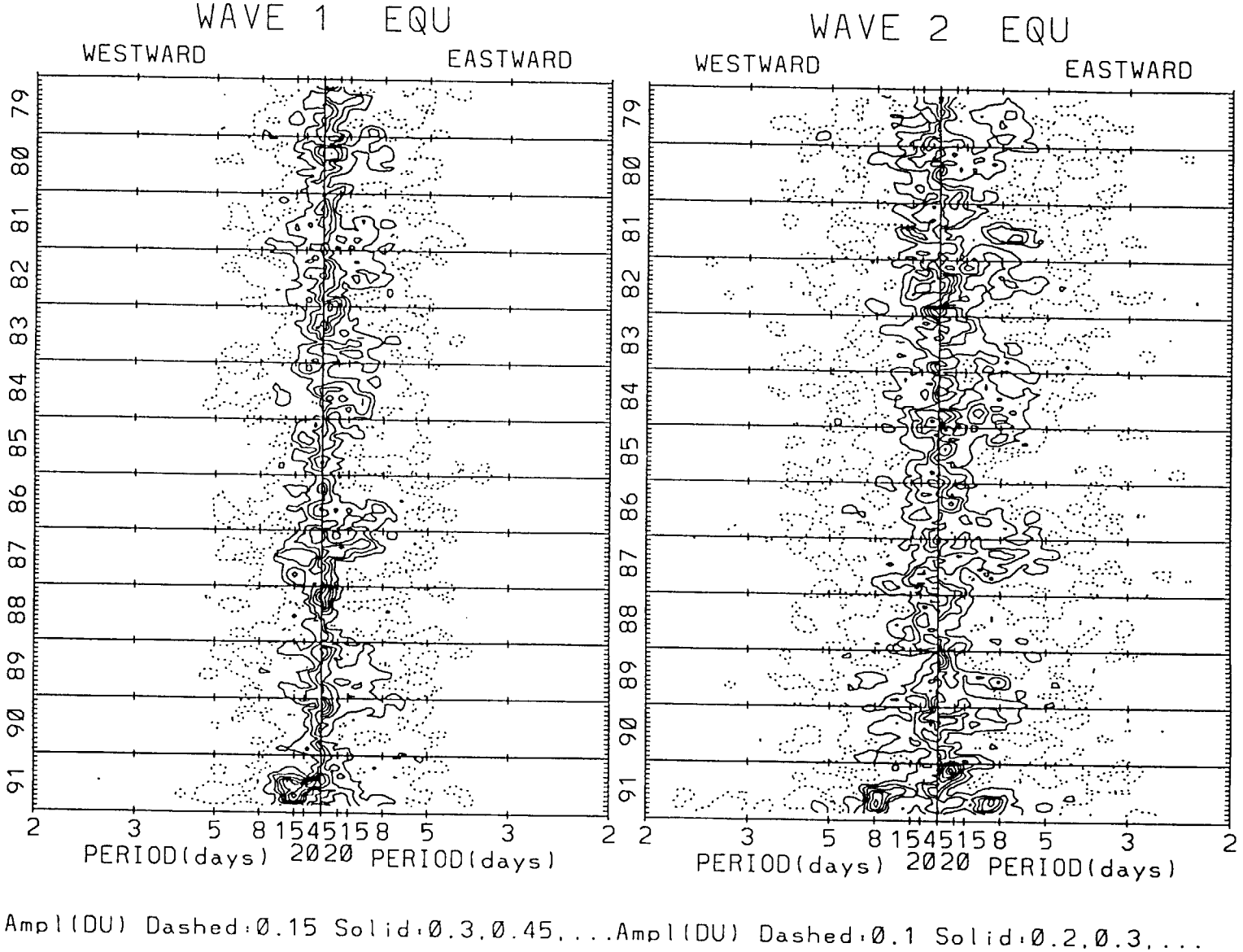

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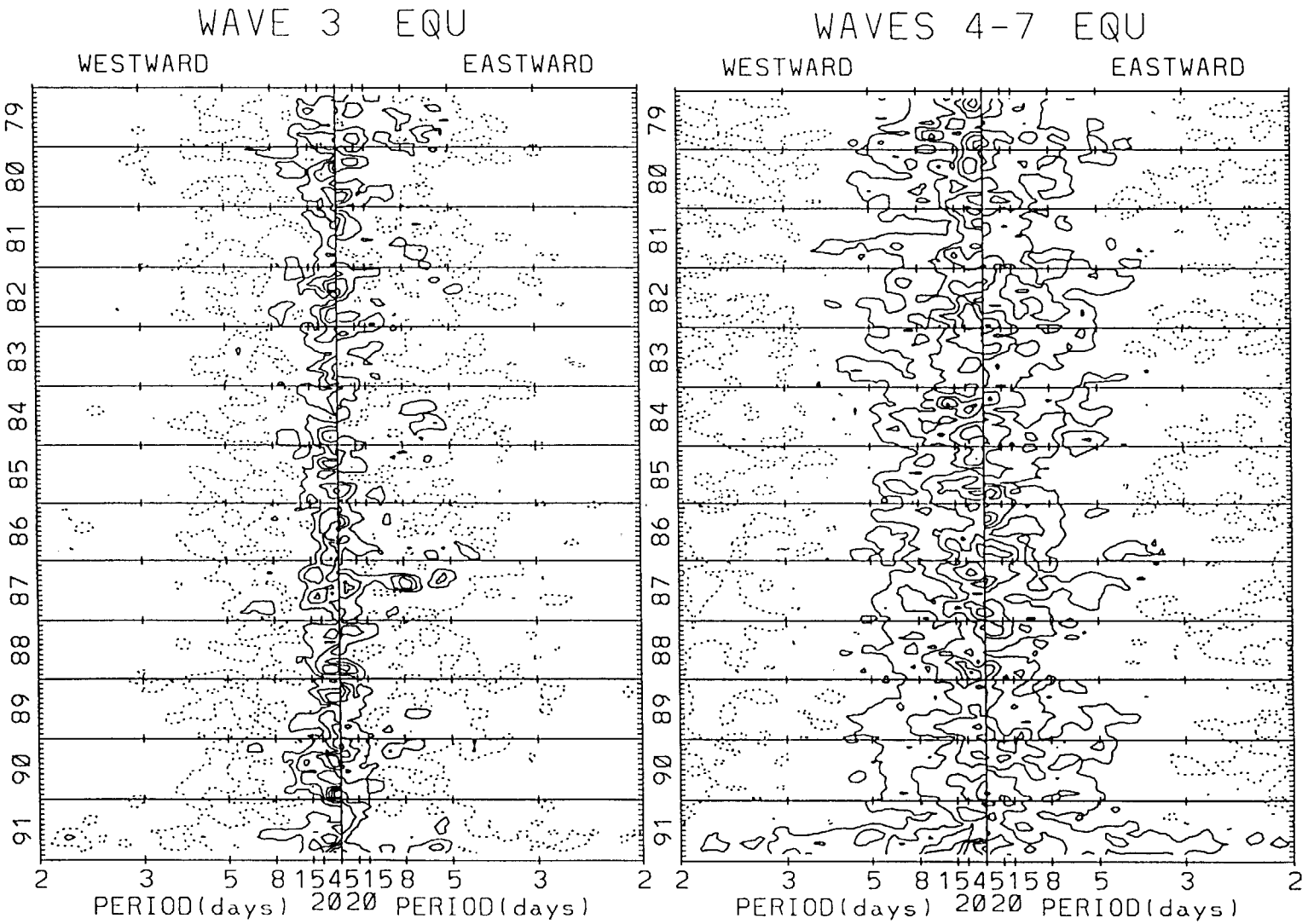

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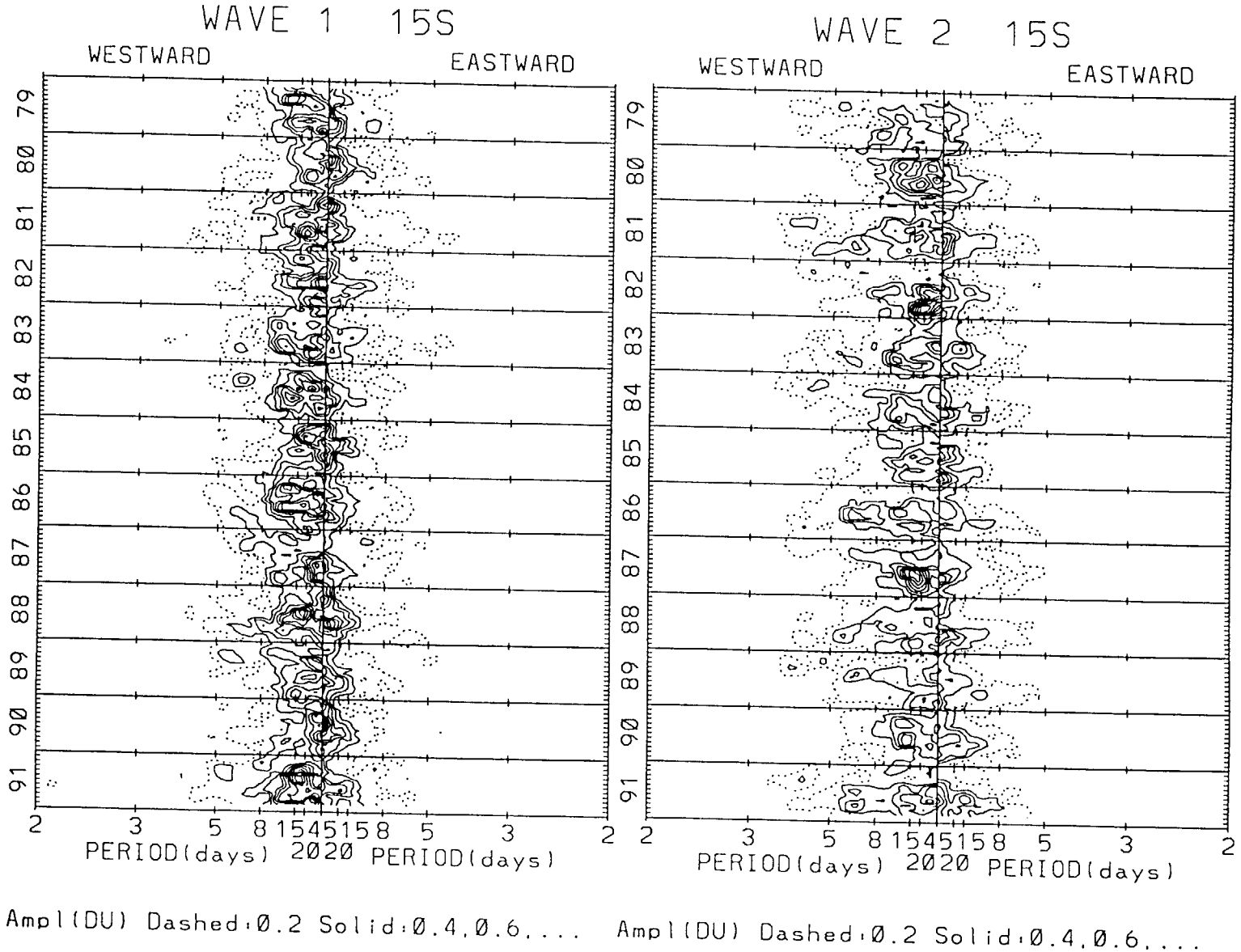

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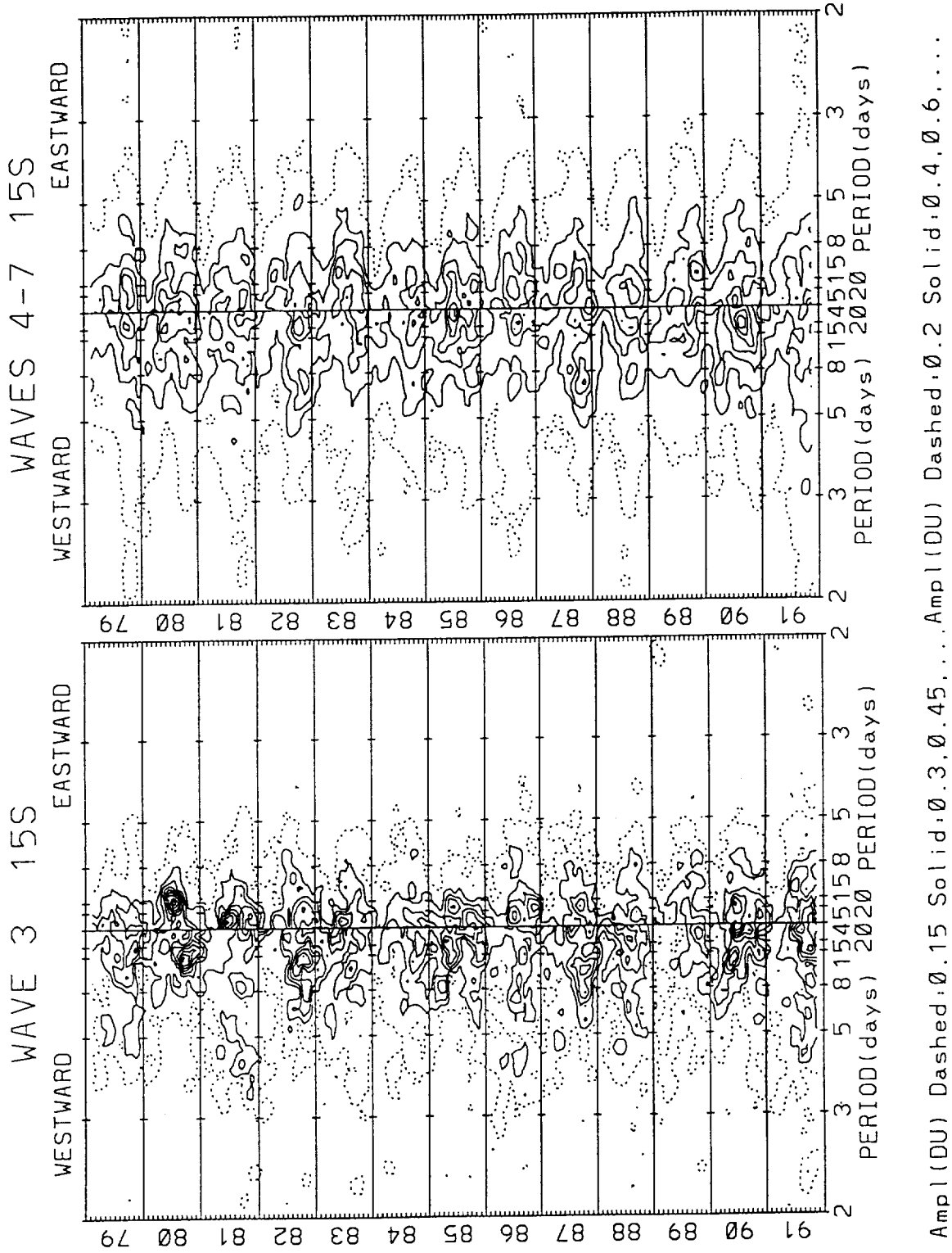

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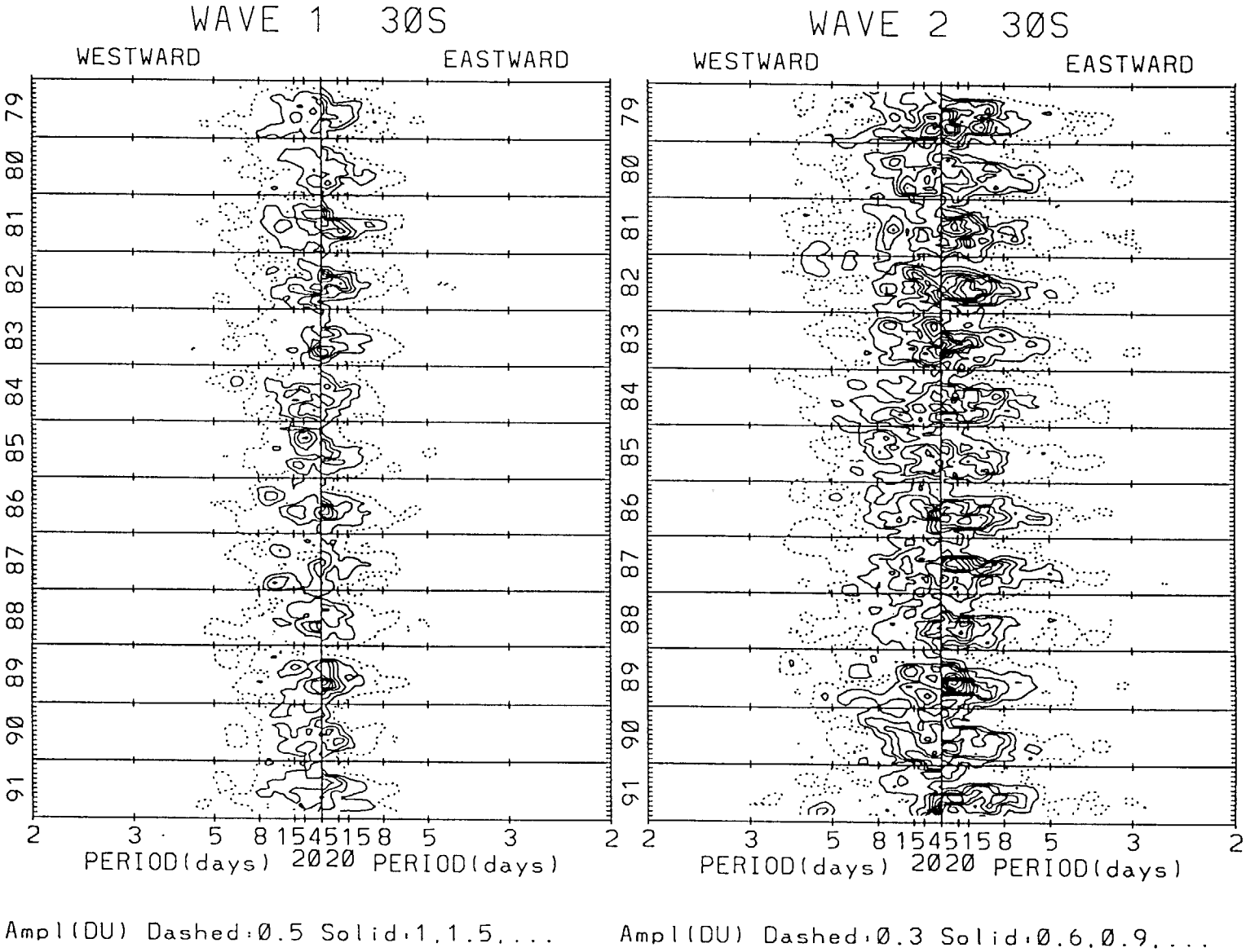

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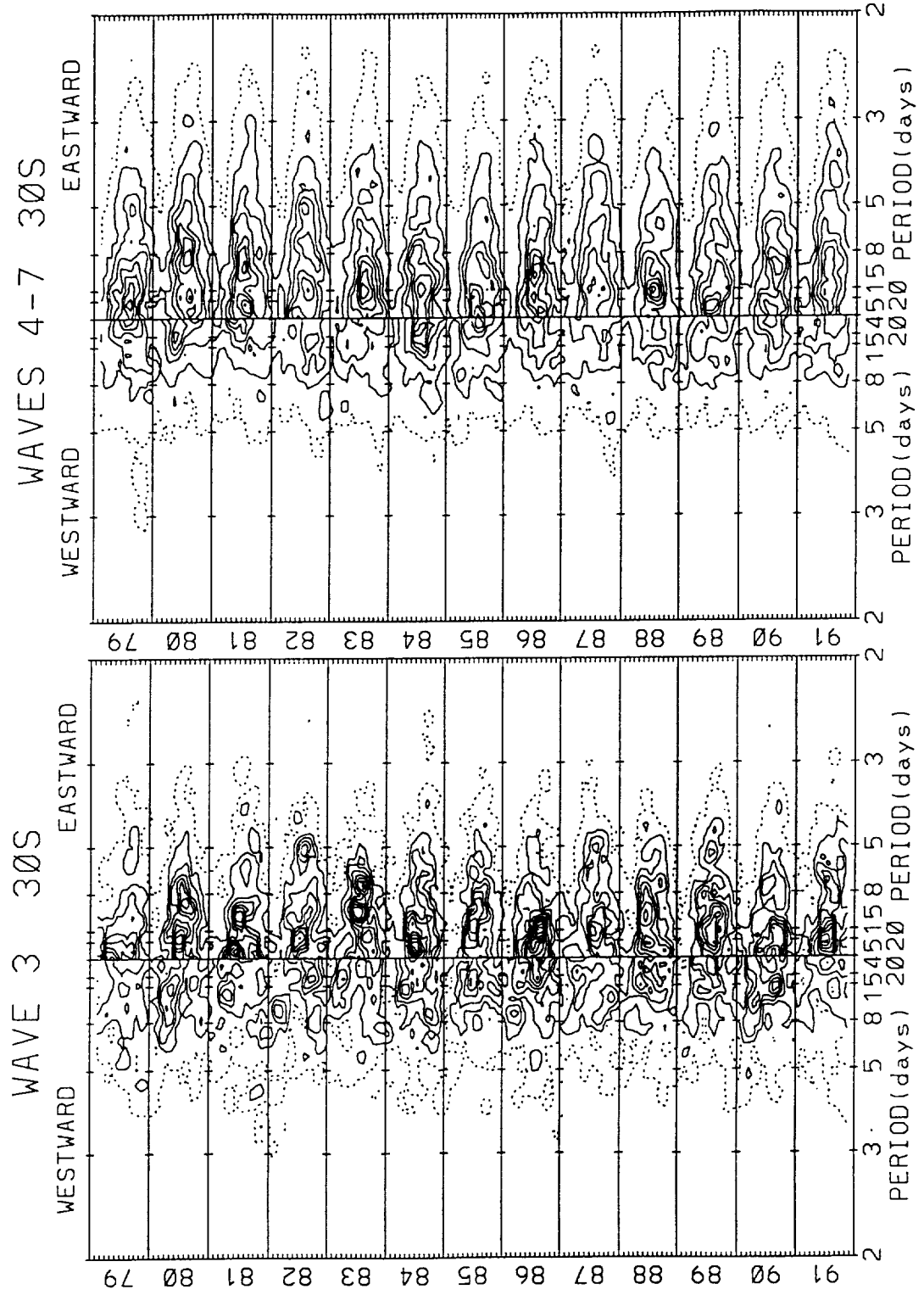

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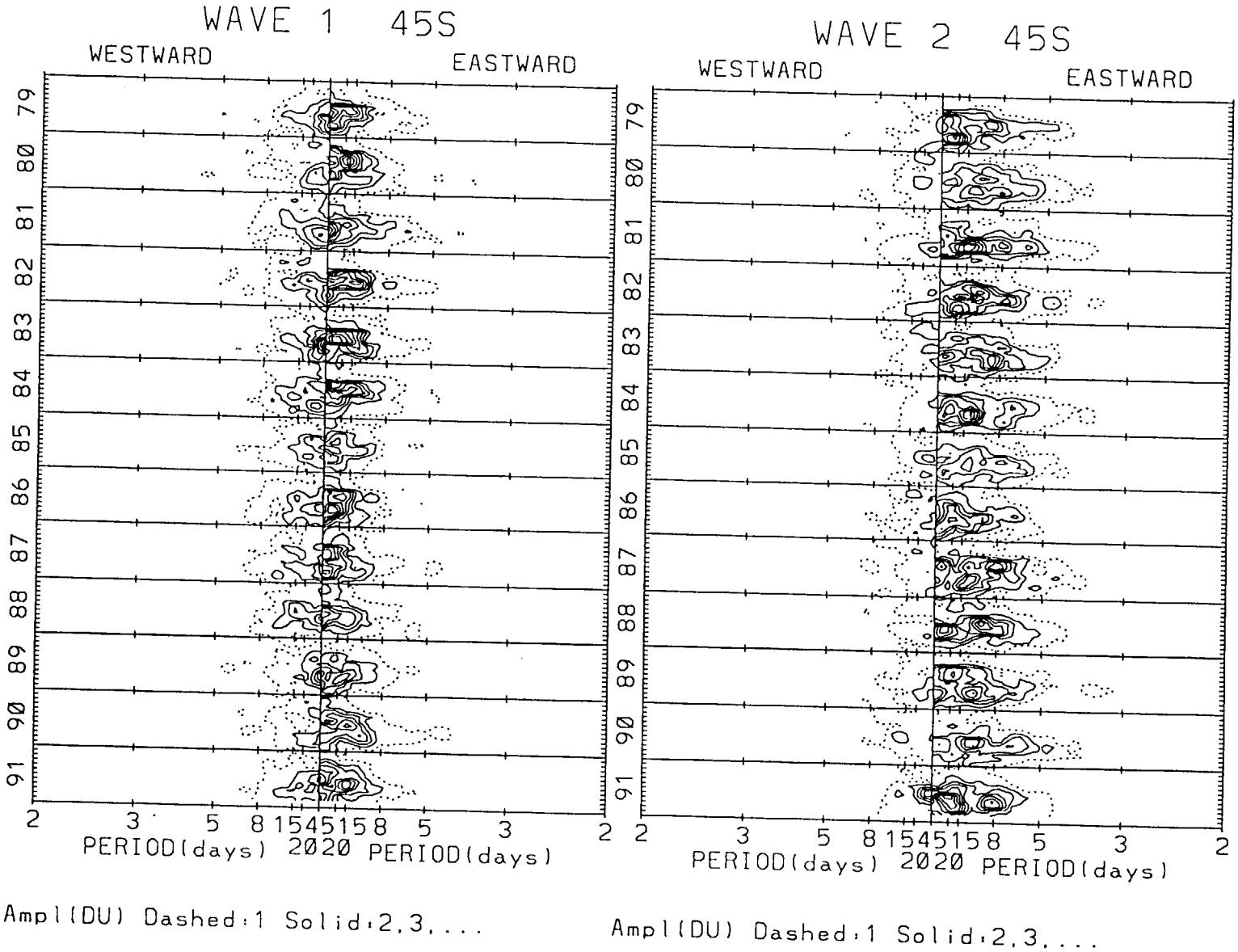

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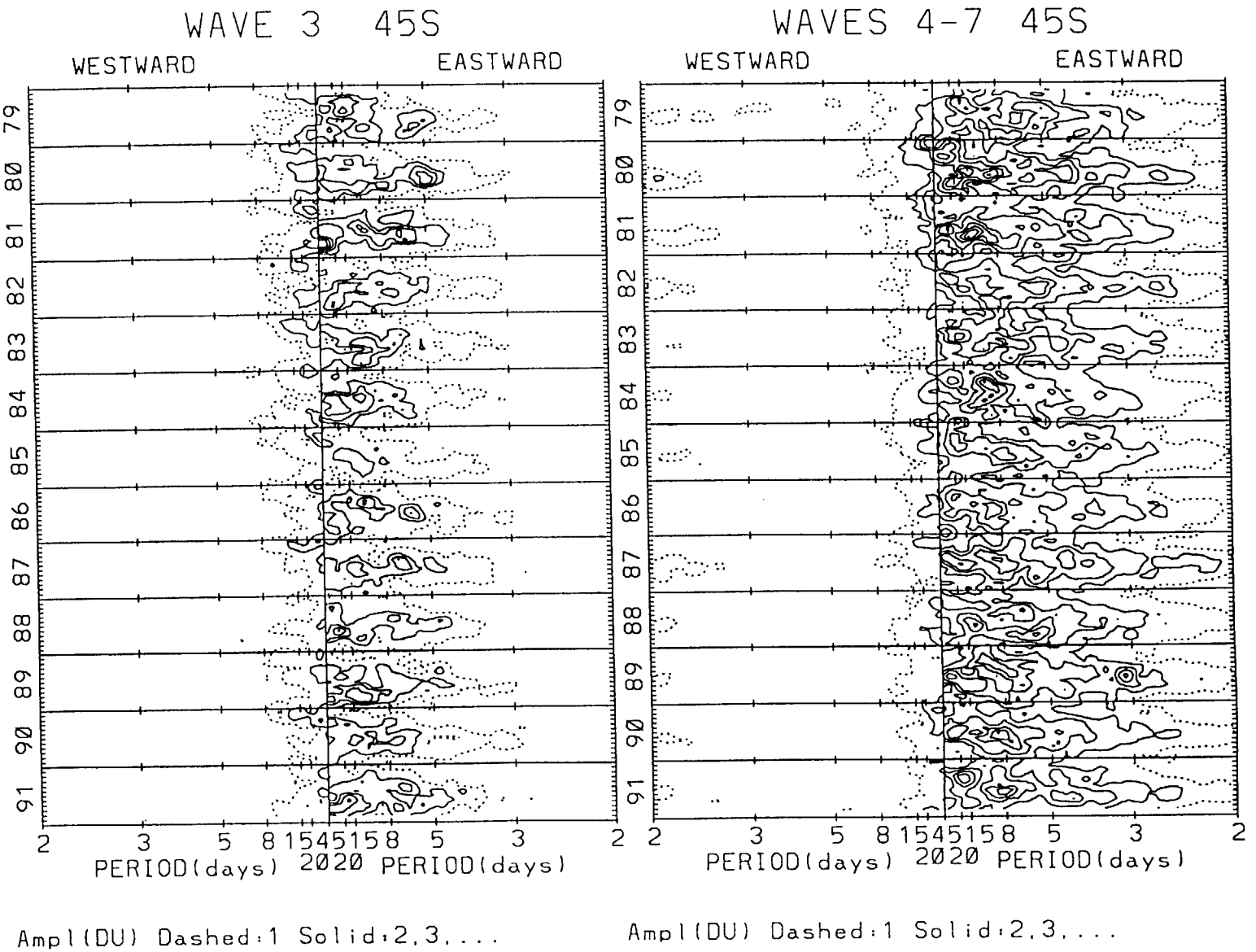

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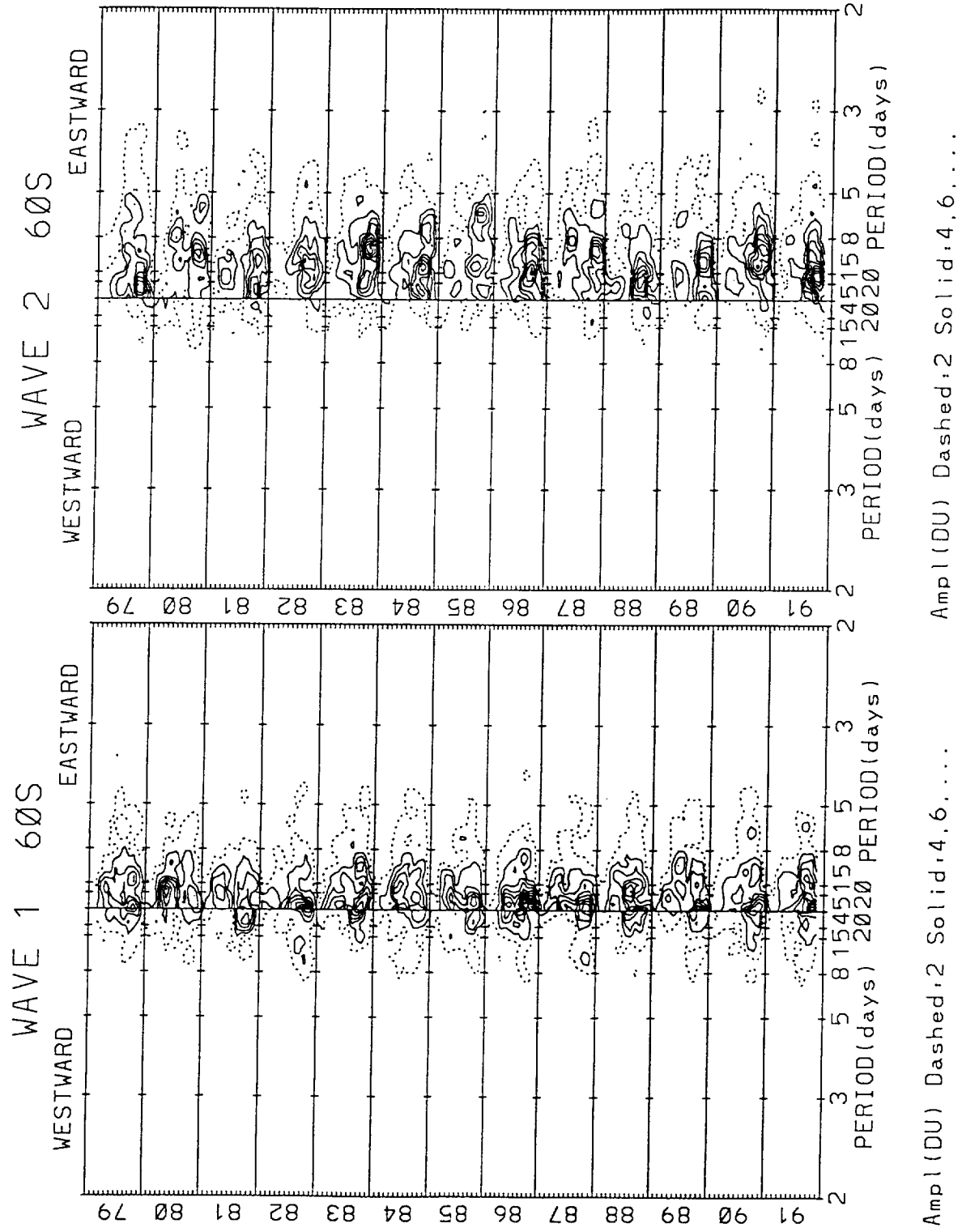

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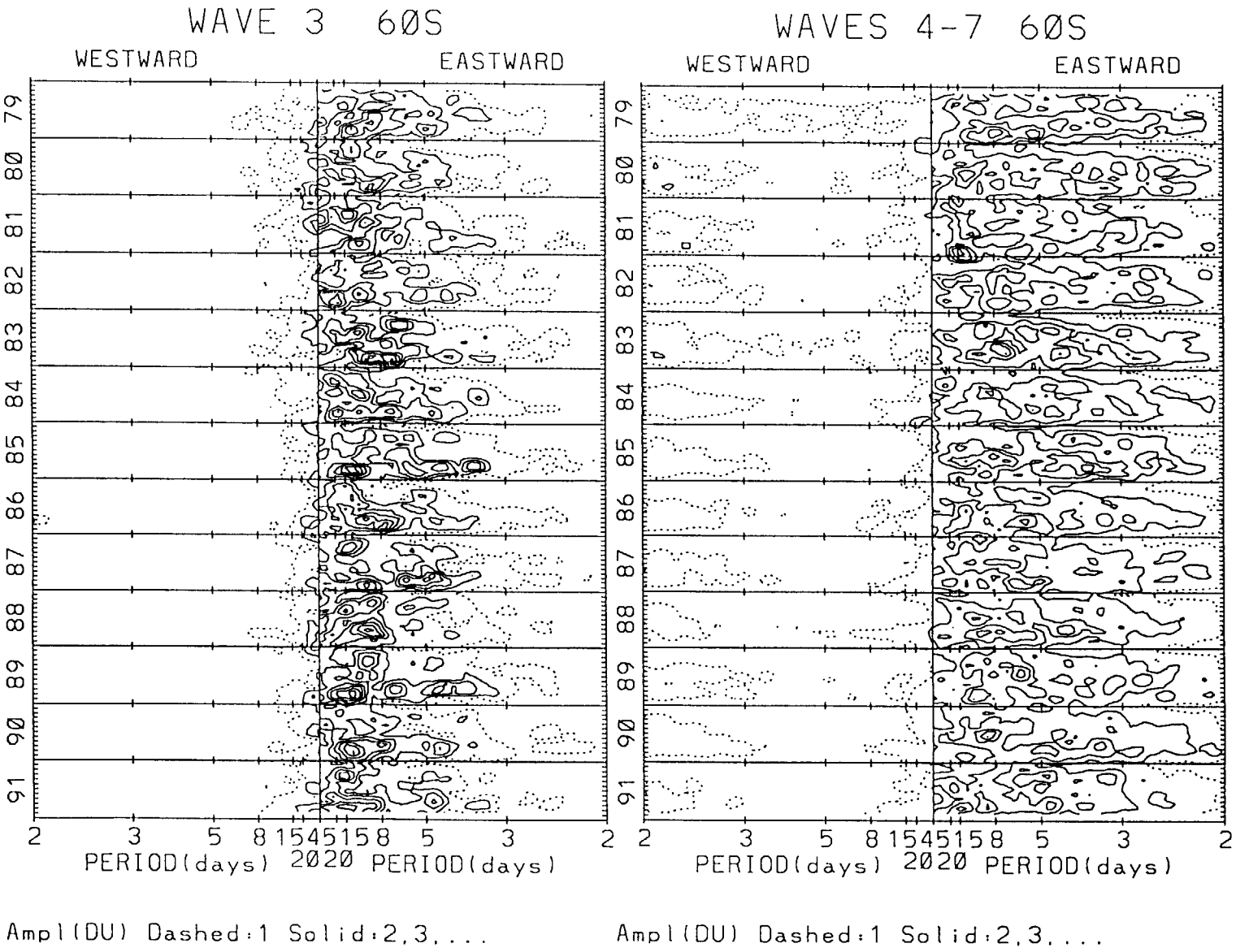

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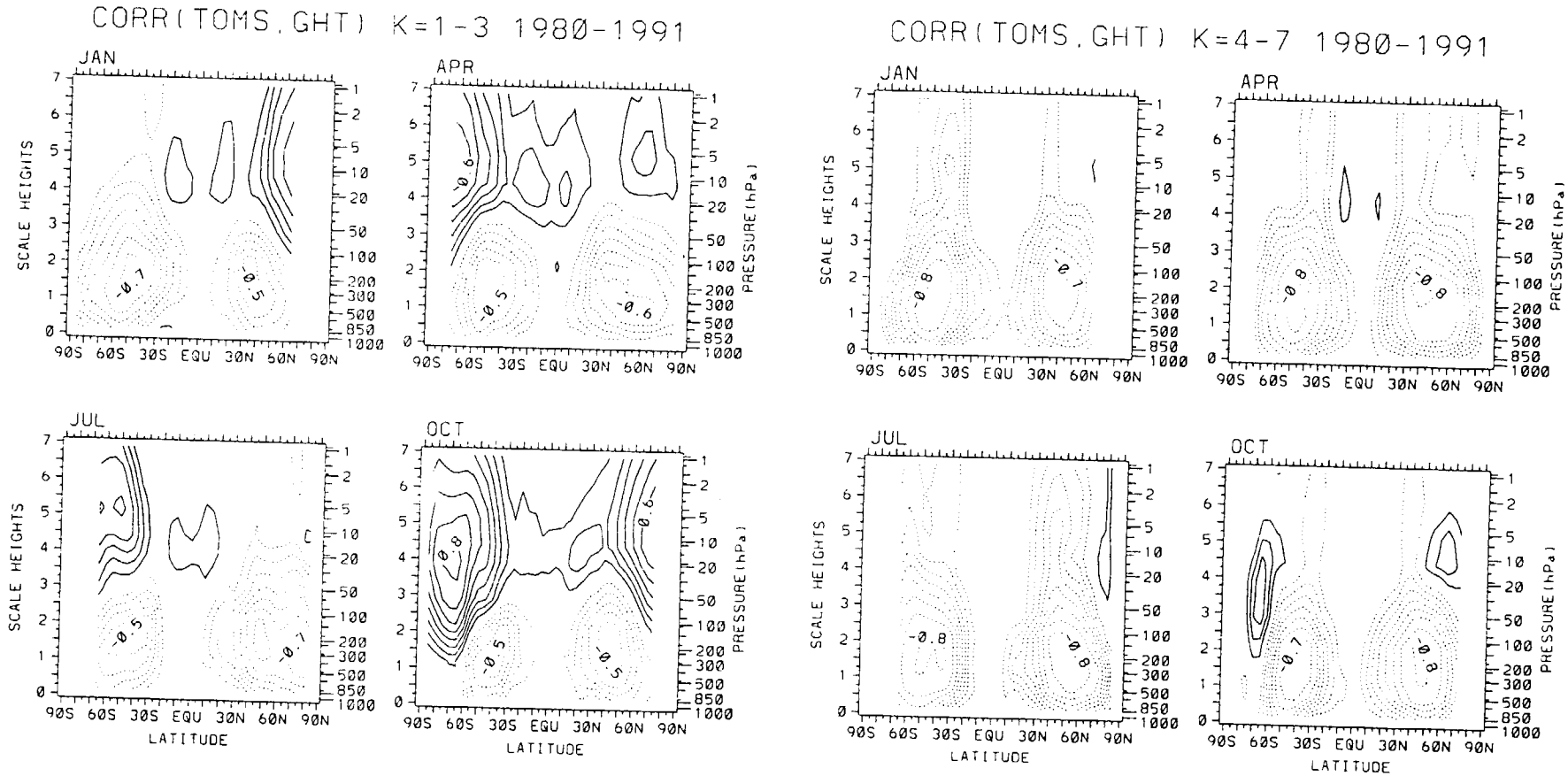

Figure 8. Zonally averaged climatological cross-correlations between 3D (latitude, longitude, pressure) geopotential heights and 2D (latitude, longitude) TOMS total ozone. Dashed (solid) contour values are 0.1,0.2, ..., 0.9 (-0.1,-0.2,..,-0.9). Left: waves 1-3 in TOMS and BMO heights. Right: waves 4–7. Monte Carlo results are (see text for methodology): critical correlation magnitudes 0.27, 0.38, 0.51, and 0.56 correspond to significance levels α=5, 0.5, 0.01, and 0.001%, respectively.

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13. ABSTRACT *(Maximum 200 words)*

This reference publication presents selected results from space-time spectyral analyses of 13 years of version 6 daily global ozone fields from the Total Ozone Mapping Spectrometer (TOMS). One purpose is to illustrate more quantitatively the well-known richness of structure and variation in total ozone. A second purpose is to provide, for use by modelers and for comparison with other analysts' work, quantitative measures of zonal waves 1, 2, 3, and medium-scale waves 4-7 in total ozone. Their variations throughout the year and at a variety of latitudes are presented, from equatorial to polar regions. The 13-year averages are given, along with selected individual years which illustrate year-to-year variability.

The largest long-wave amplitudes occur in the polar winters and early springs of each hemisphere, and are related to strong wave amplification during major warming events. In low latitudes, total ozone wave amplitudes are an order of magnitude smaller than at high latitudes. However, TOMS fields contain a number of equatorial dynamical features, including Rossby-gravity and Kelvin waves.

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