Angular momentum of the atmosphere

Variations of atmospheric relative angular momentum and length of day

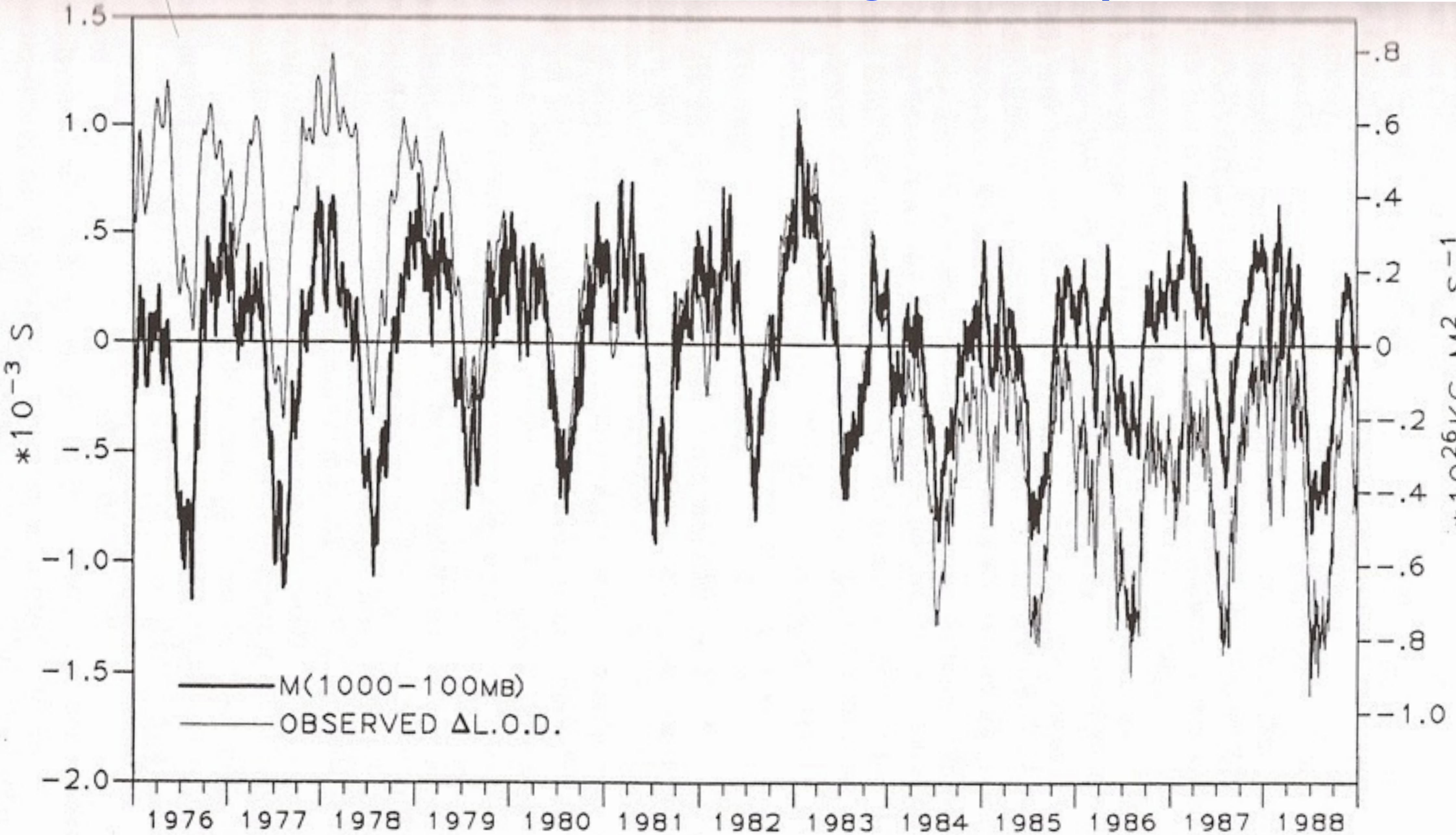
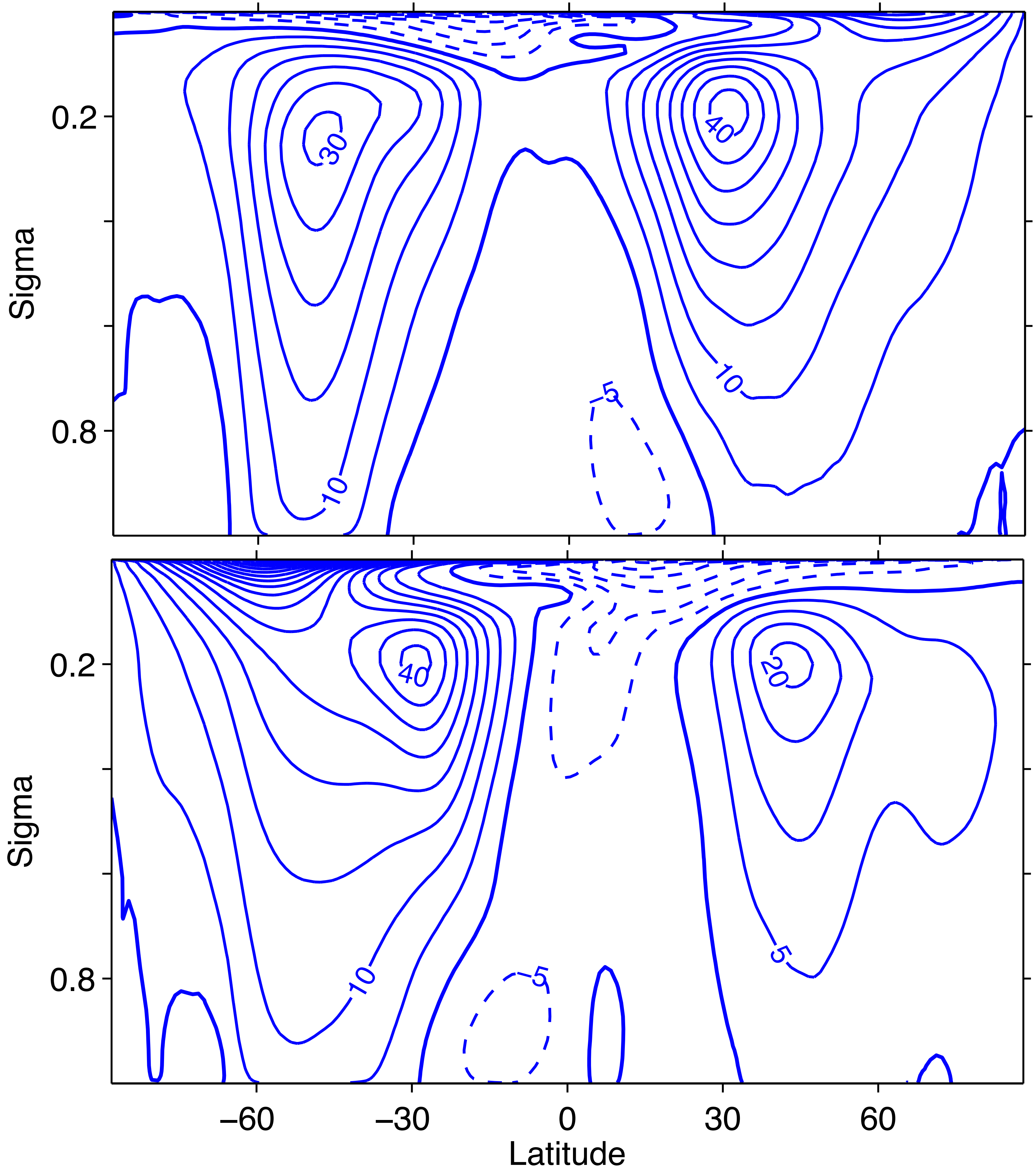


FIGURE 11.2. Time series of daily values of the relative westerly angular momentum M_r of the global atmosphere between 1000 and 100 mb based on NMC analyses in units of 10^{26} kg m^2 s^{-1} (heavy solid line; scale on right) and values of the length of day (LOD) in units of 10^{-3} s (thin solid line; scale on left) for the years 1976–1988. The daily LOD data are based on an optimal combination of observing techniques prior to April 1985 with approximately 5-day effective resolution and on VLBI (very long base line interferometry) observations with approximately daily resolution from April 1985 (based on data from Rosen *et al.*, 1990, updated by Salstein).

Fig. 1 *Peixoto and Oort, Fig 11.2*



DJF

JJA

Mean zonal wind (m/s) in latitude-height plane

Fig. 2 *ERA40 reanalysis 1980-2001*

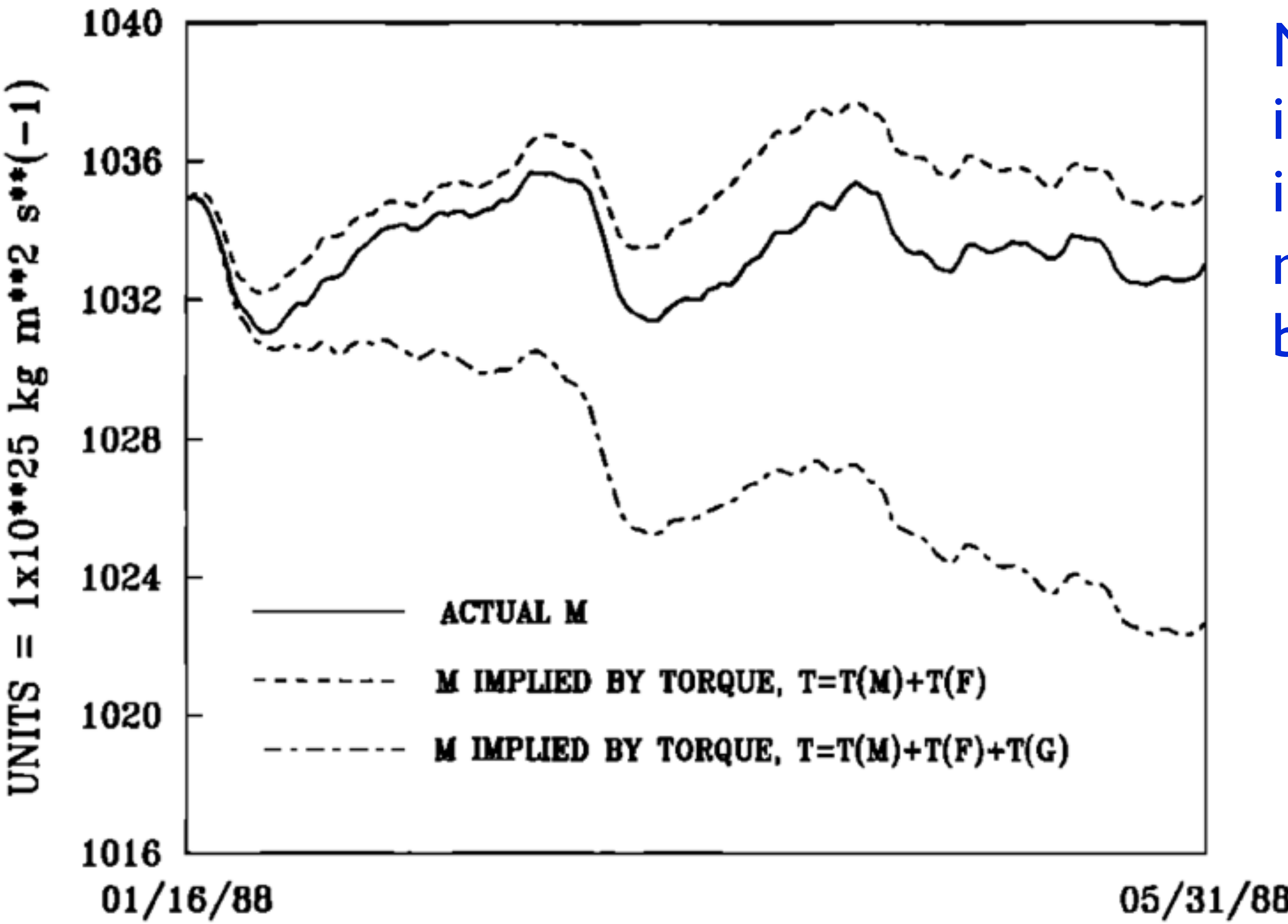


Figure 2. The actual angular momentum (solid line) versus the predicted angular momentum with $T = T_M + T_F$ (dashed line) and $T = T_M + T_F + T_G$ (dash-dotted line) from January 16 to May 31, 1988.

NCEP reanalysis: imbalance in the angular momentum budget

Torques
T(M): mountain
T(F): frictional
T(G): gravity-wave

Fig. 3

Huang, JGR, 1999; Fig 2

Northward flux of momentum (m^2s^{-2})

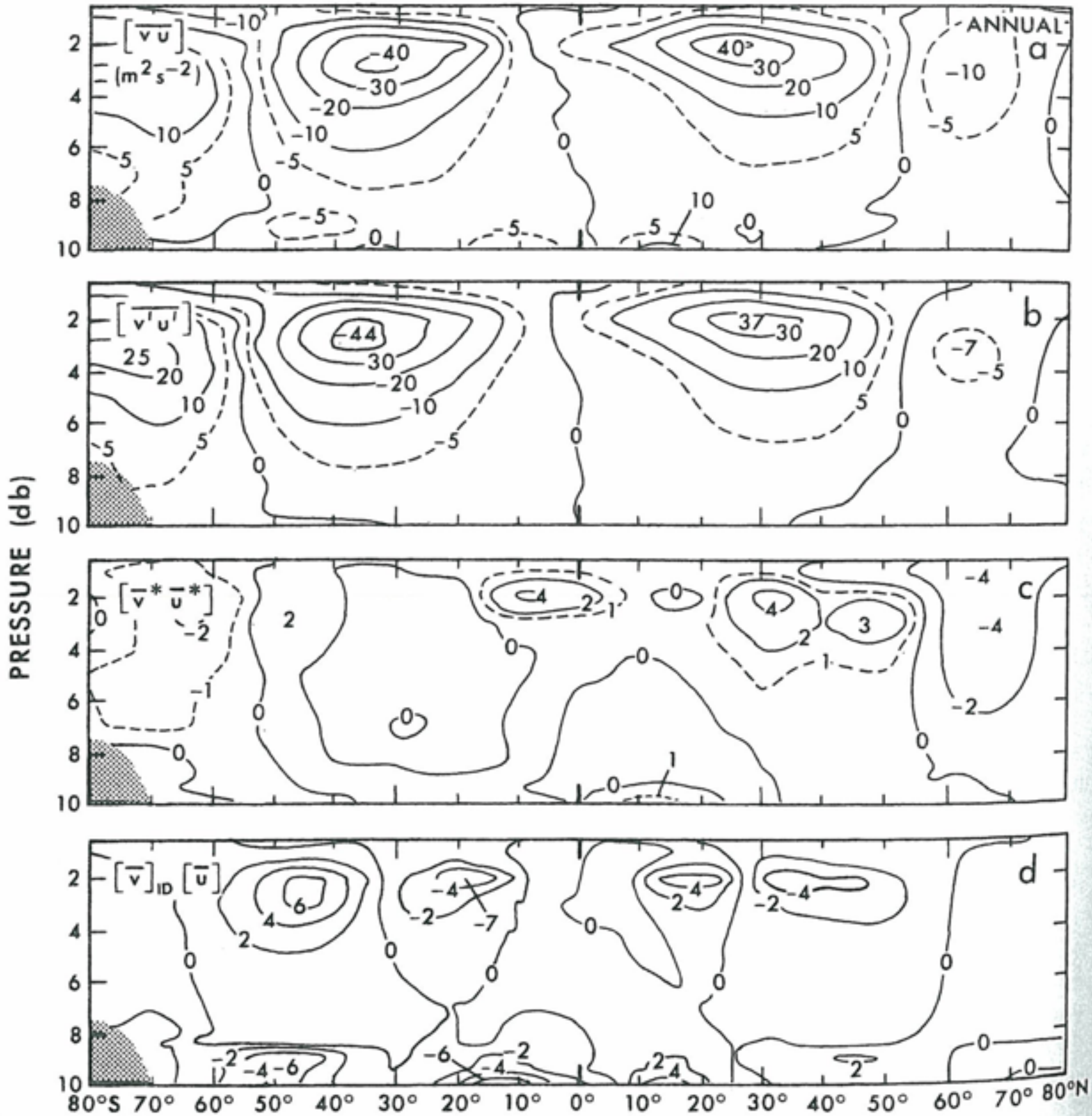


FIGURE 11.7. Zonal-mean cross sections of the northward flux of momentum by all motions (a), transient eddies (b), stationary eddies (c), and mean meridional circulations (d) in $m^2\ s^{-2}$ for annual-mean conditions (from Oort and Peixoto, 1983).

Total

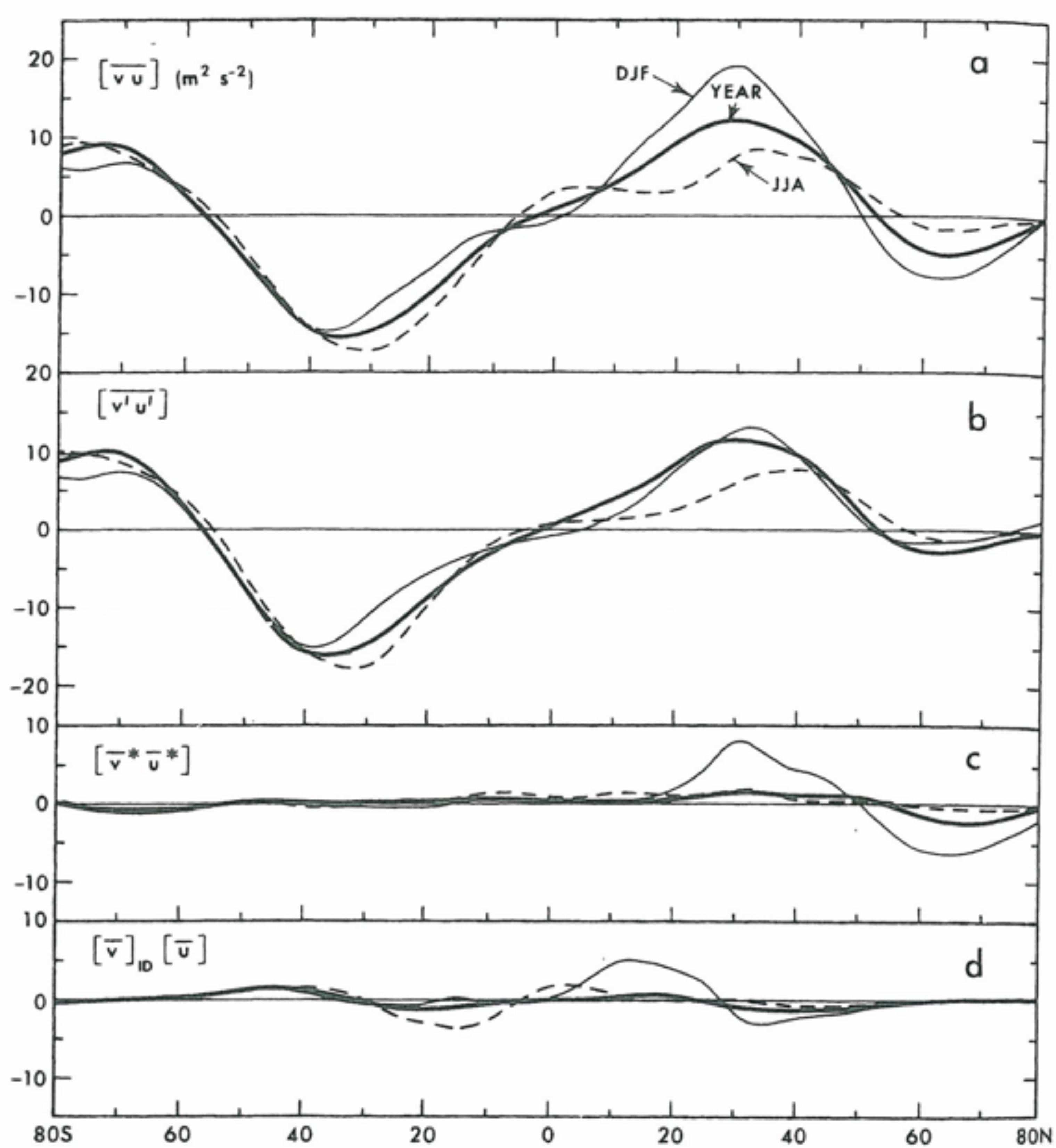
Transient

Stationary

Mean

Fig. 4 *Peixoto and Oort, Fig 11.7*

Northward flux of momentum (m^2s^{-2})



Total

Transient

Stationary

Mean

FIGURE 11.8. Meridional profiles of the vertical- and zonal-mean northward transport of momentum by all motions (a), transient eddies (b), stationary eddies (c), and mean meridional circulations (d) in units of $m^2 s^{-2}$ for annual, DJF, and JJA mean conditions [to convert to angular momentum transport units of 10^{18} kg $m^2 s^{-1}$ multiply values by $2\pi R^2 \cos^2 \phi (p_0/g) = 2.56 \cos^2 \phi$, where $2\pi R \cos \phi$ = length of latitude circle, $R \cos \phi$ = distance to rotation axis, and p_0/g = mass per unit area $\approx 10^4$ kg m^{-2}; from Oort and Peixoto, 1983].

Fig. 5 *Peixoto and Oort, Fig 11.8*

Mean surface torques on the atmosphere (10^{18} kg m^2 s^{-2})

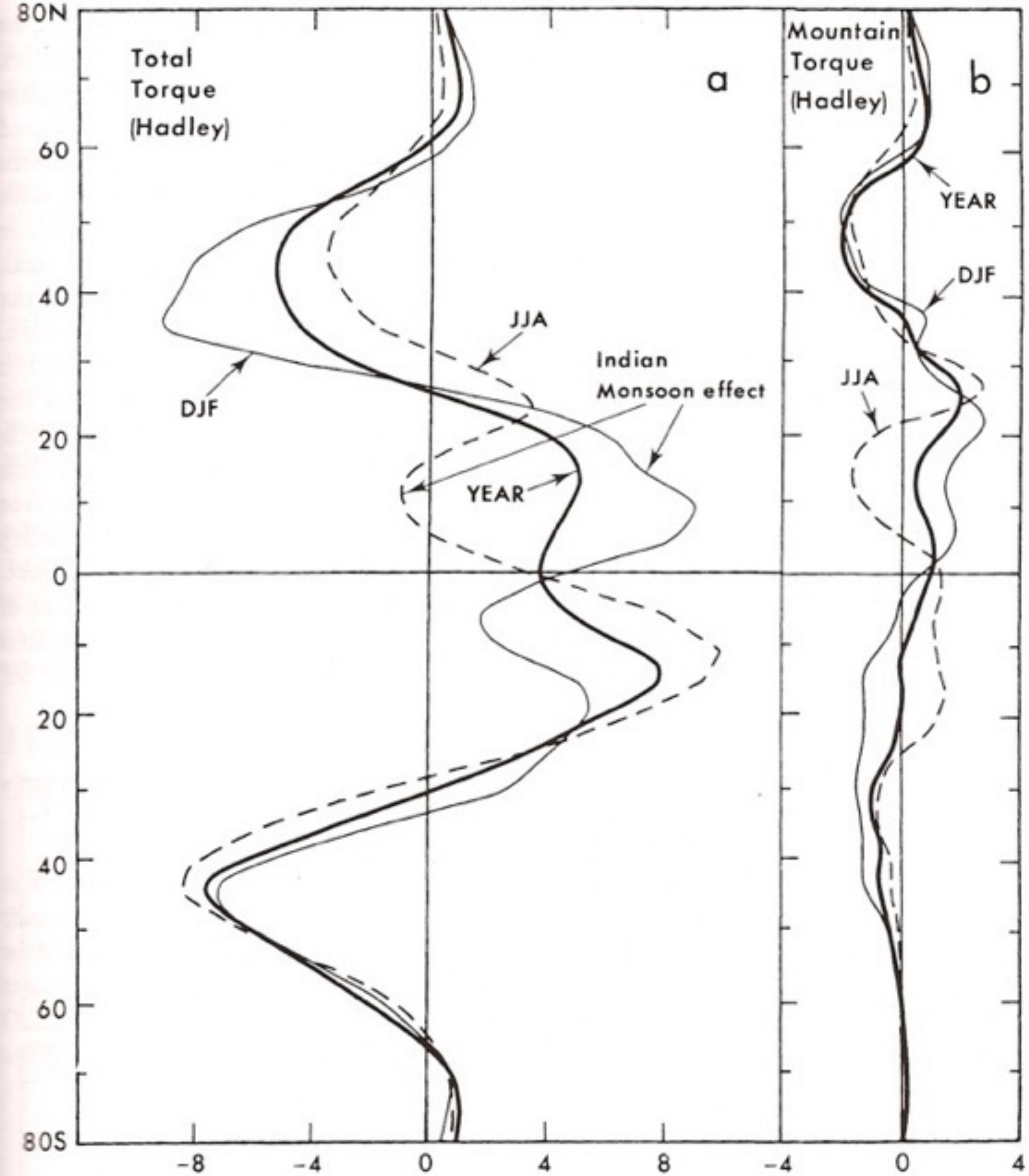


FIGURE 11.12. Meridional profiles of the mean surface torque (due to friction and mountains) (a) integrated over 5° latitude belts in Hadleys (1 Hadley = 10^{18} kg m^2 s^{-2}) and the mean mountain torque (b) after Newton (1971a) in the same units (after Oort and Peixoto, 1983).

Fig. 6 *Peixoto and Oort, Fig 11.12*

Schematic of dynamic angular momentum transports and surface torques

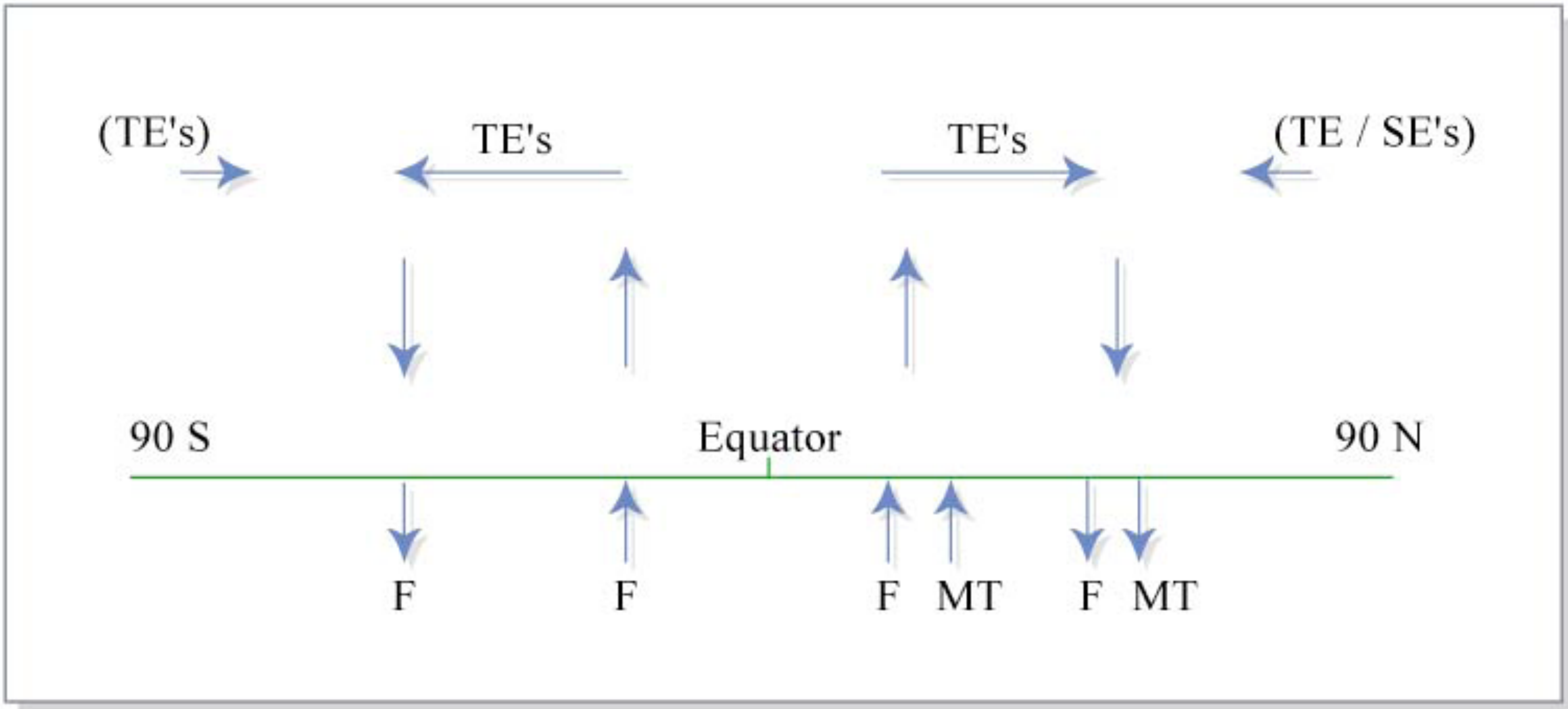


Fig. 7 *Figure credit : MIT OCW*

Cospectrum of v and T at 300hPa, 47N, DJFM

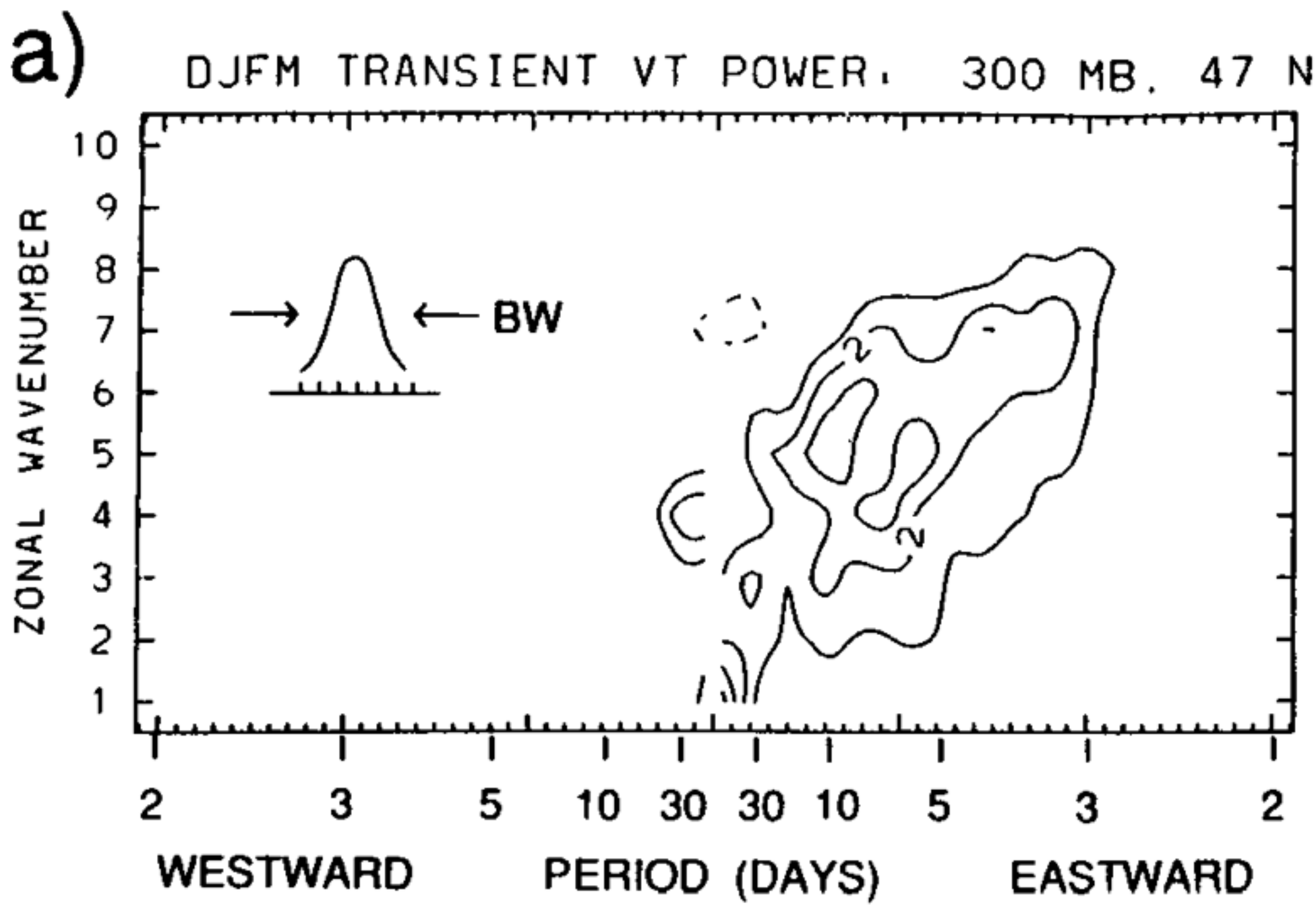


Fig. 8 *Randel and Held, JAS, 1991: fig 1*

Cospectrum of v and T at 300hPa

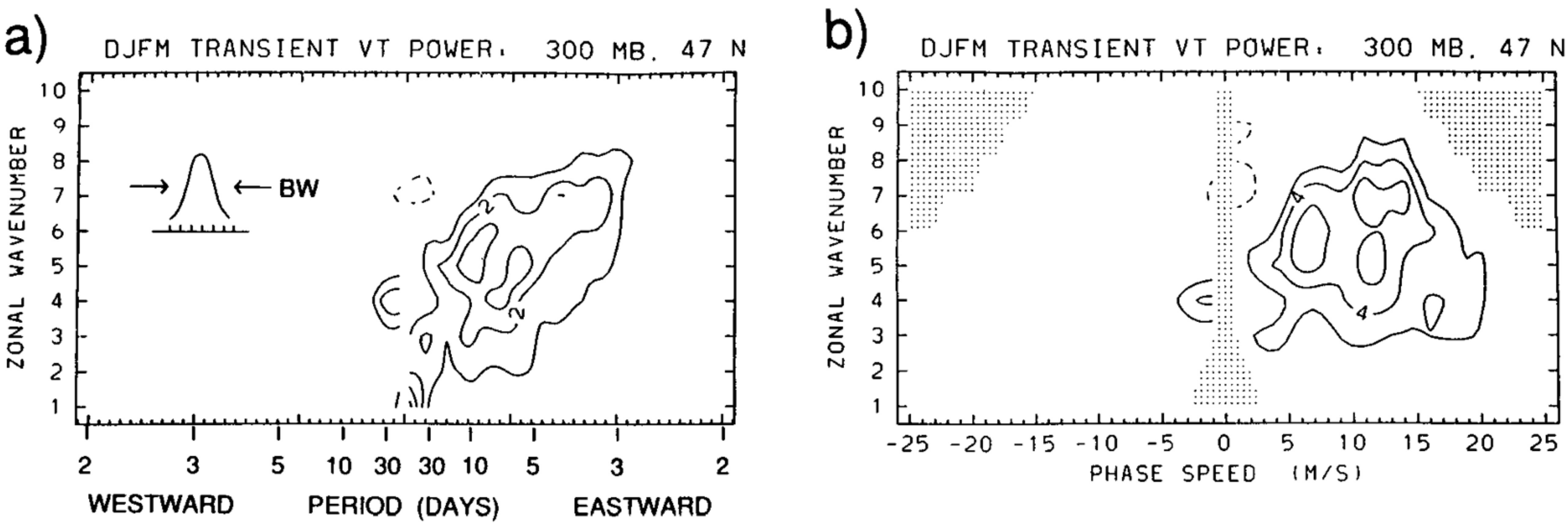
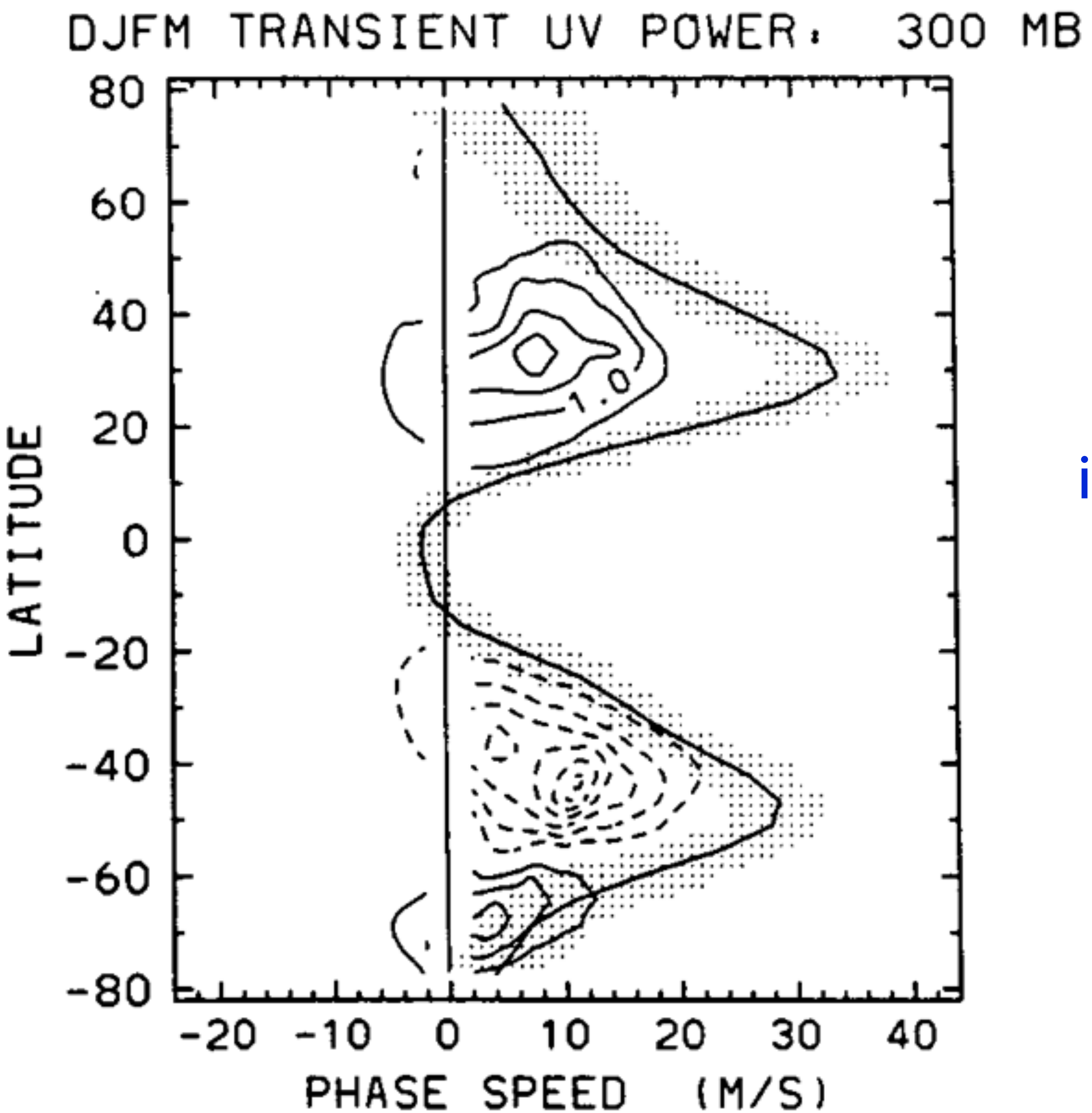


FIG. 1. Zonal wavenumber–frequency covariance spectra of $\overline{v'T'}$ at 300 mb, 47°N during DJFM. The spectral bandwidth (BW) associated with the Gaussian spectral window (2) is also shown. Spectral density contour interval is 0.01 K m s^{-1} · $\Delta\omega^{-1}$, with $\Delta\omega$ the unit frequency interval of (2π/120 days). (b) Zonal wavenumber phase speed covariance spectra calculated from (a) via (3). Contour interval is 0.02 K m s^{-1} · Δc^{-1}, with Δc the unit phase speed interval of 1.0 m s^{-1}. Shaded regions denote wavenumber–phase speed combinations which are unresolved at this latitude (as discussed in text).

Fig. 9 *Randel and Held, JAS, 1991: fig 1*



Cospectrum of u and v in phase speed at 300hPa

Fig. 10 *Randel and Held, JAS, 1991*

FIG. 6. Contours of 300 mb transient eddy momentum flux versus latitude and phase speed for DJFM (left) and JJAS (right). Contour interval is 0.50 $m^2 s^2 \cdot \Delta c^{-1}$, with zero contours omitted. Heavy lines in each panel denote seasonal average zonal mean zonal wind, and shading denotes plus and minus one daily standard deviation.

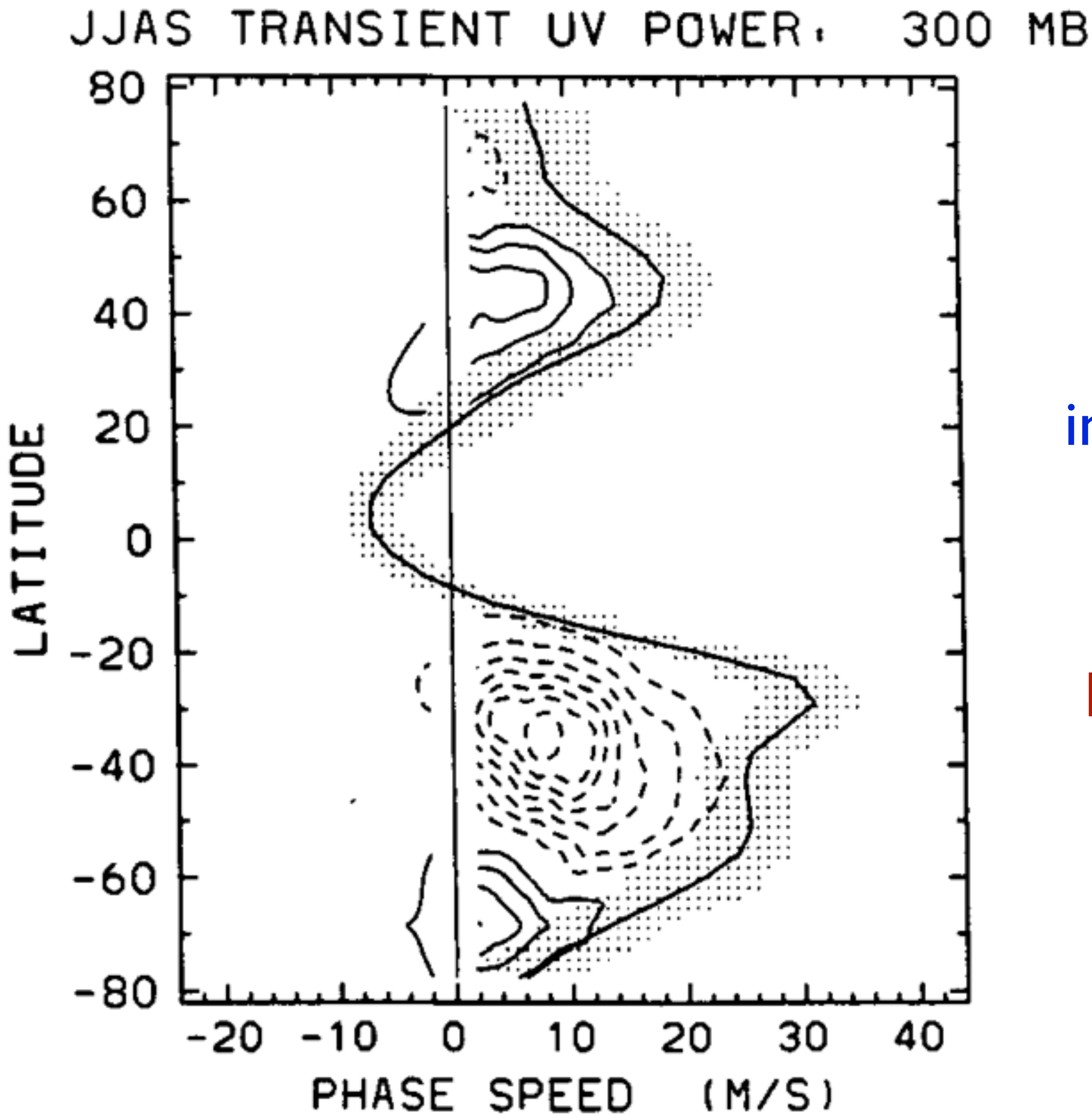


FIG. 6. Contours of 300 mb transient eddy momentum flux versus latitude and phase speed for DJFM (left) and JJAS (right). Contour interval is 0.50 $m^2 s^2 \cdot \Delta c^{-1}$, with zero contours omitted. Heavy lines in each panel denote seasonal average zonal mean zonal wind, and shading denotes plus and minus one daily standard deviation.

Cospectrum of u and v in phase speed at 300hPa (JJAS)

Fig. 11 *Randel and Held, JAS, 1991*

EP flux and divergence - winter, transient

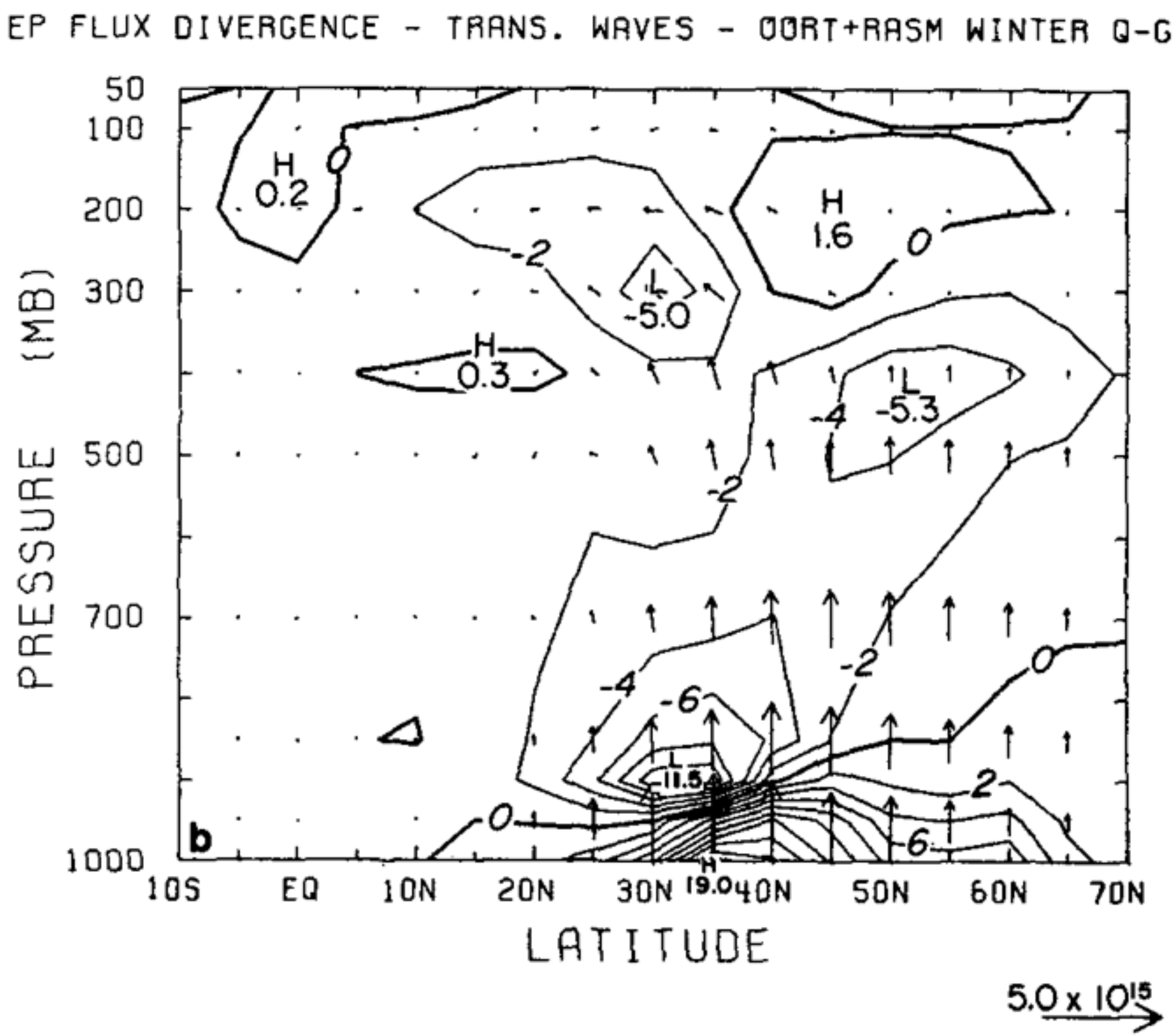


Fig. 12

(Reproduced in Edmon et al, 1980)

Transformed Eulerian mean (TEM) circulation (10^9 kg s^{-1})

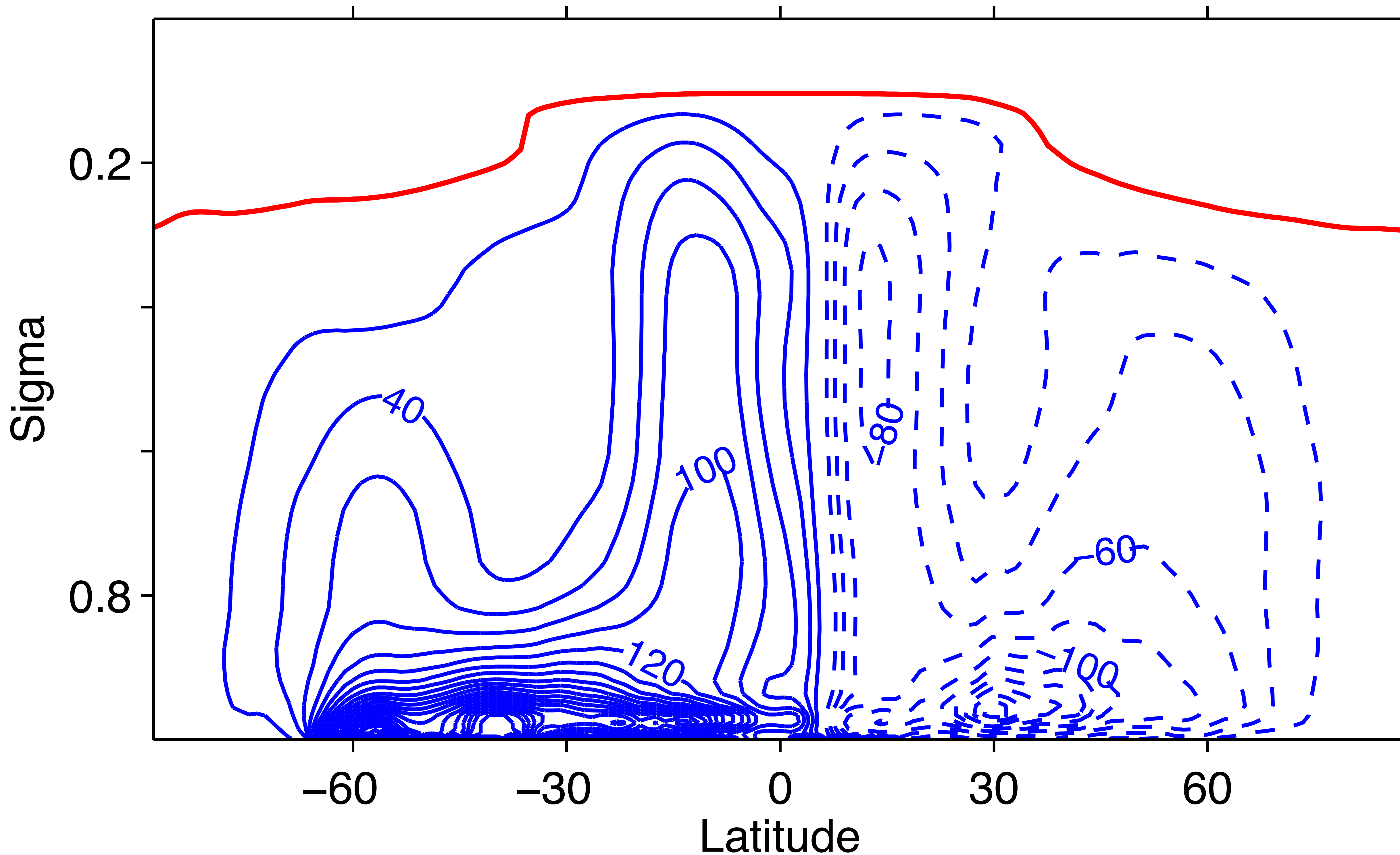
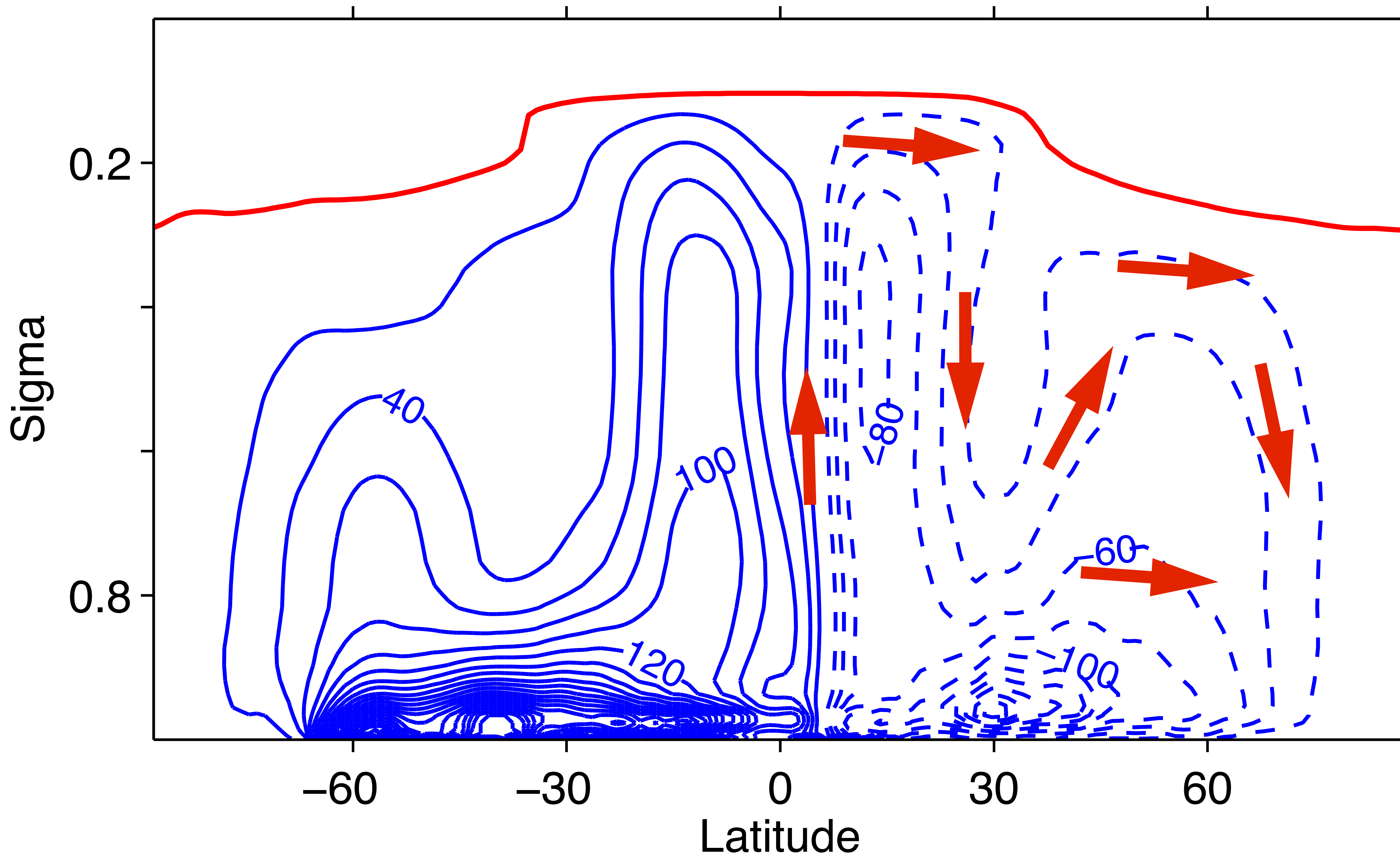


Fig. 13

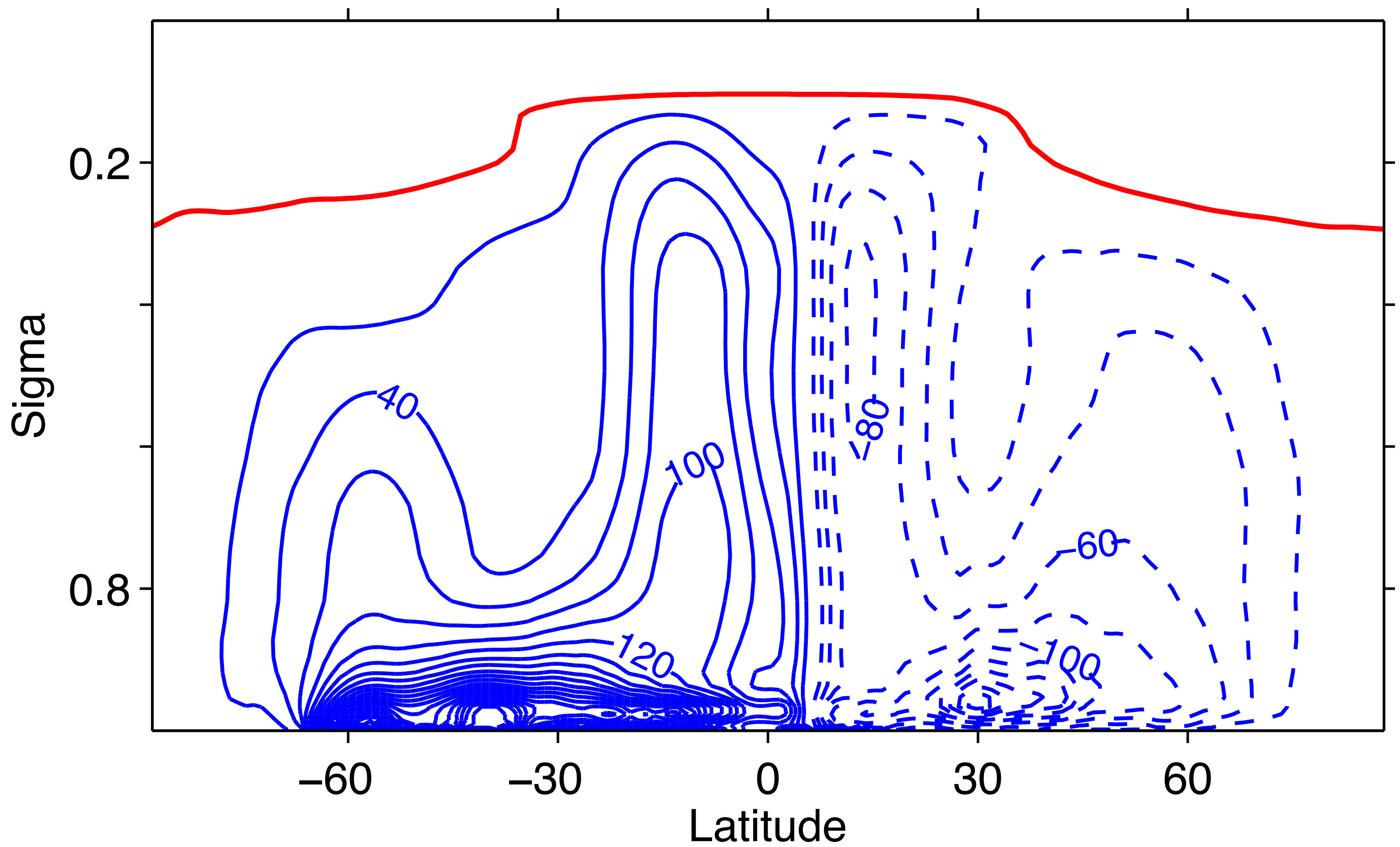
ERA40 1980-2001

Transformed Eulerian mean (TEM) circulation (10^9 kg s^{-1})

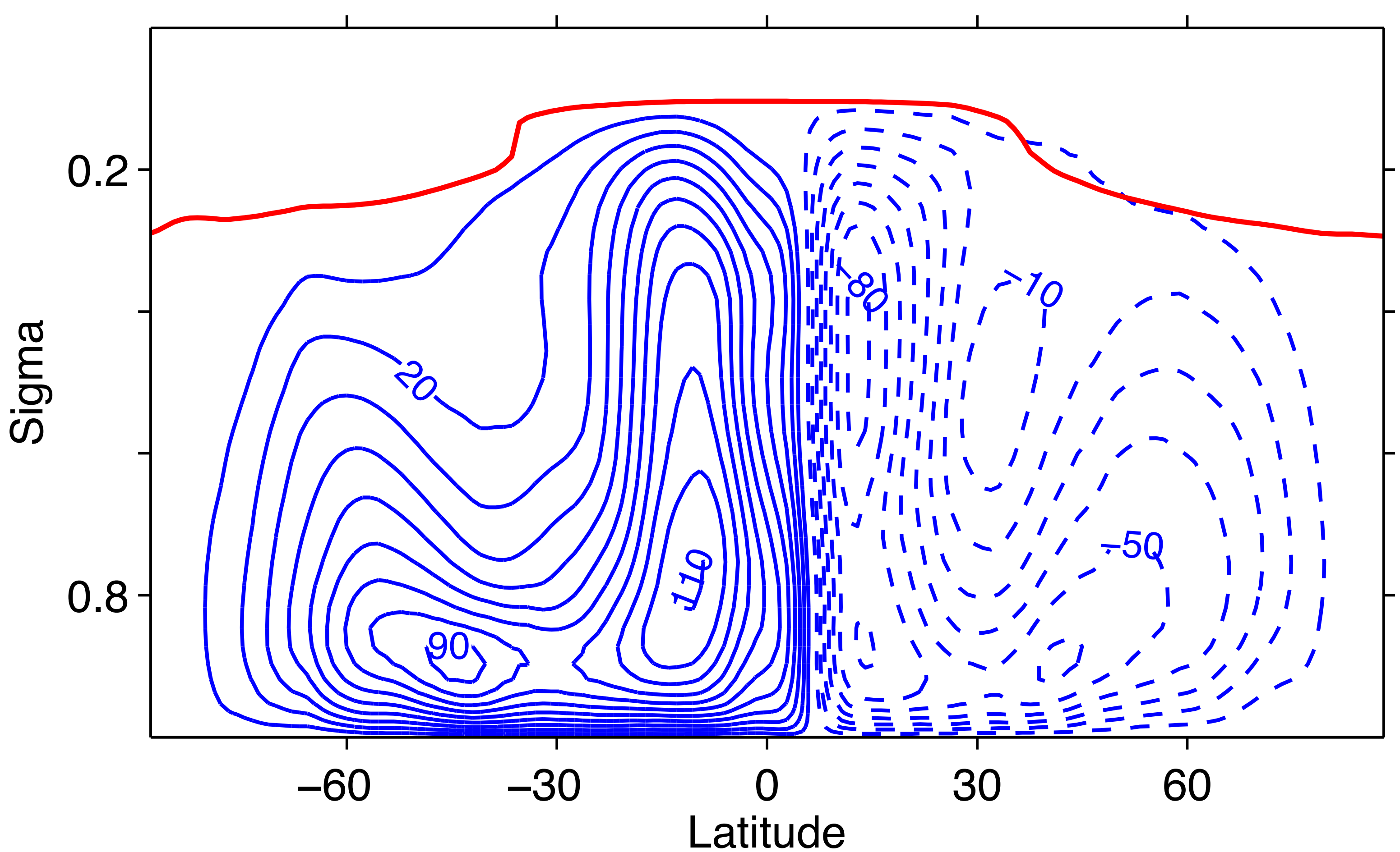


ERA40 1980-2001

Fig. 13



Transformed Eulerian mean circulation (10^9 kg s^{-1})



Dry isentropic circulation interpolated to sigma coordinates (10^9 kg s^{-1})

Fig. 14

ERA40 1980-2001