ATM 622
General Circulation

5. Energy

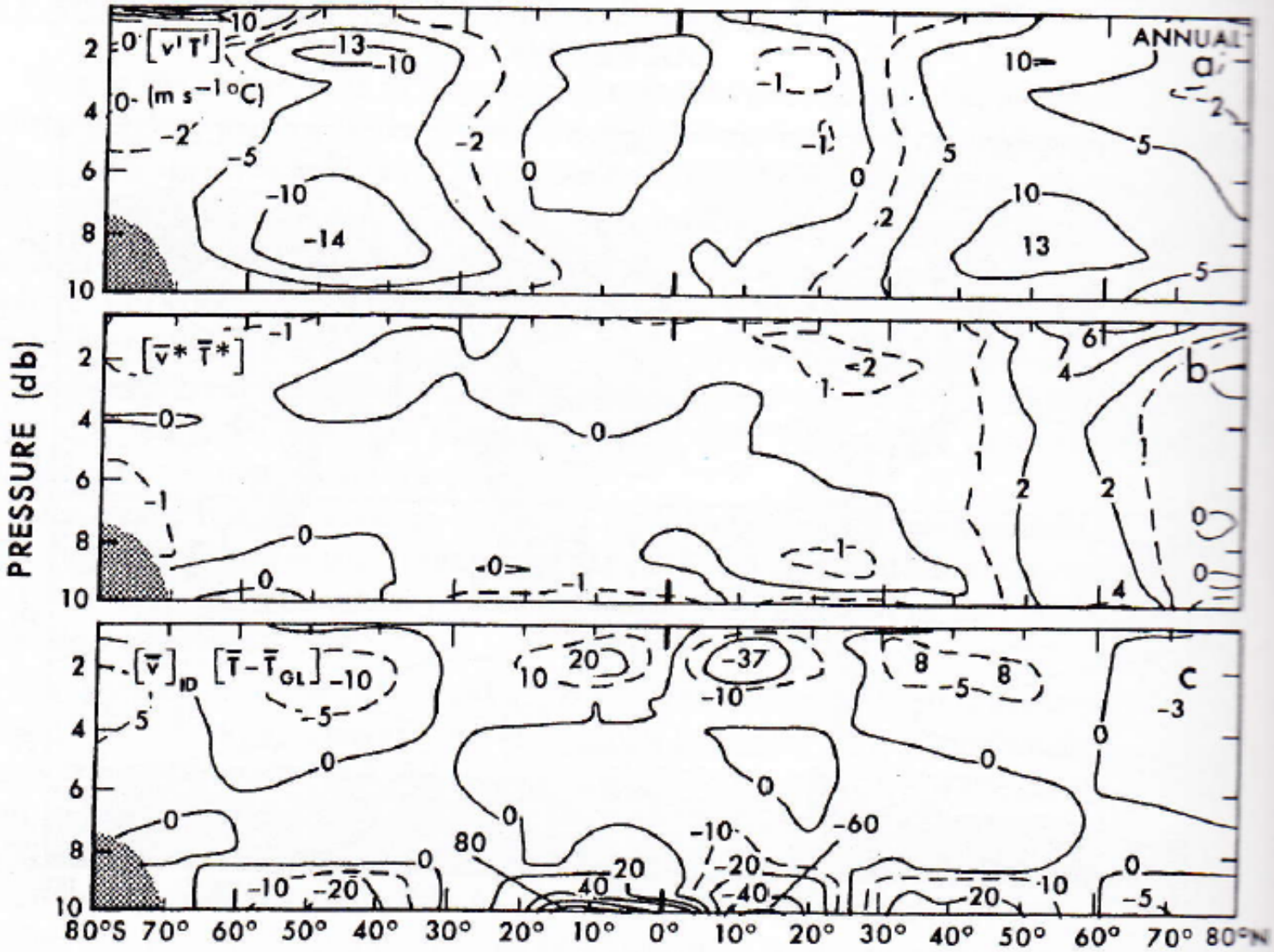


FIGURE 13.5. Zonal-mean cross sections of the northward transport of sensible heat by transient eddies (a), stationary eddies (b), and mean meridional circulations (c) in °C m s^{-1} (from Oort and Peixoto, 1983).

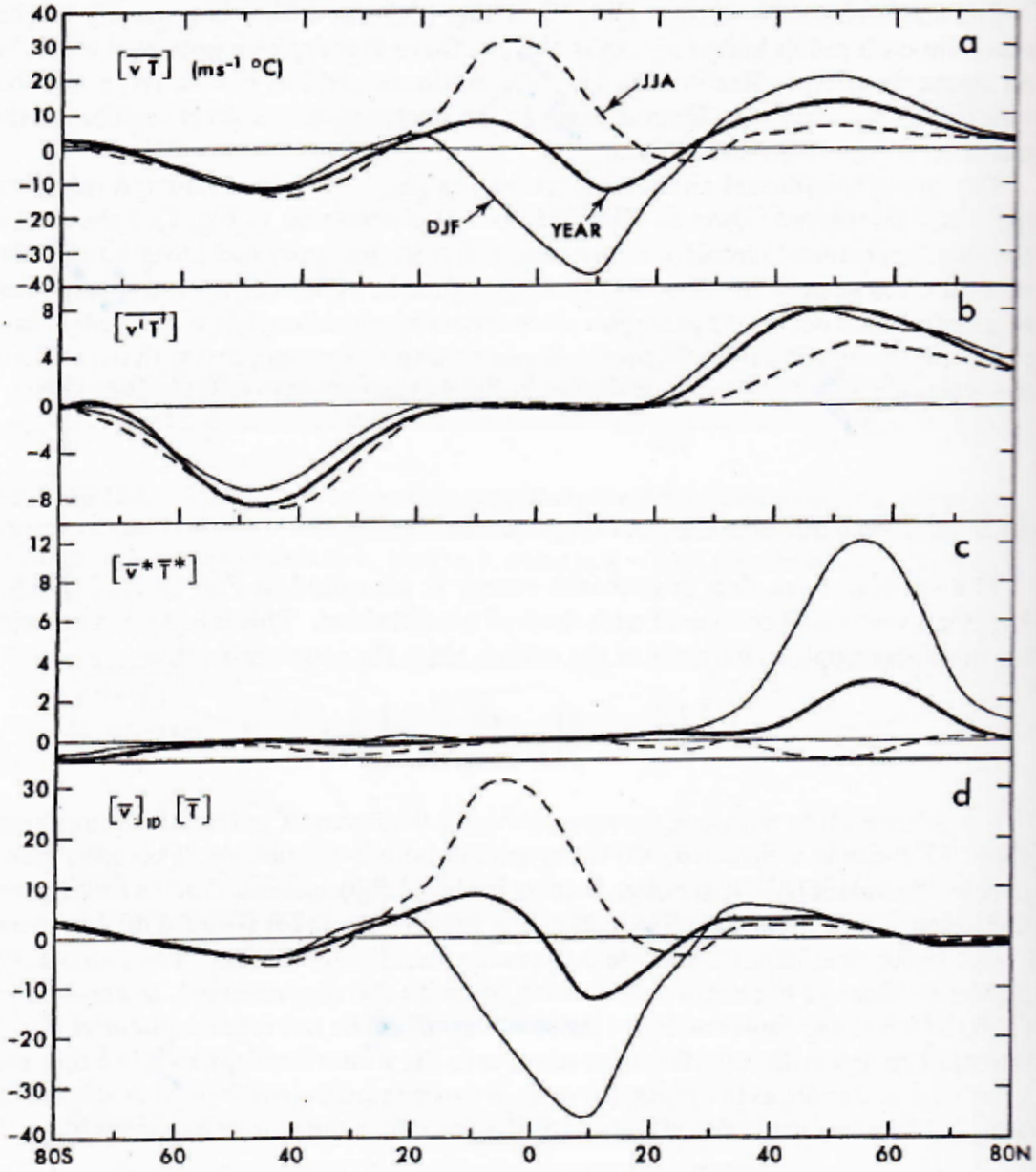


FIGURE 13.6. Meridional profiles of the zonal-and vertical-mean northward flux of sensible heat by all motions (a), transient eddies (b), stationary eddies (c), and mean meridional circulations (d) in units of °C m s^{-1} [to convert to units of 10^{15} W multiply values by $2\pi R \cos\phi\ c_p\ (p_0/g) \approx 0.4 \cos\phi$; from Oort and Peixoto, 1983].

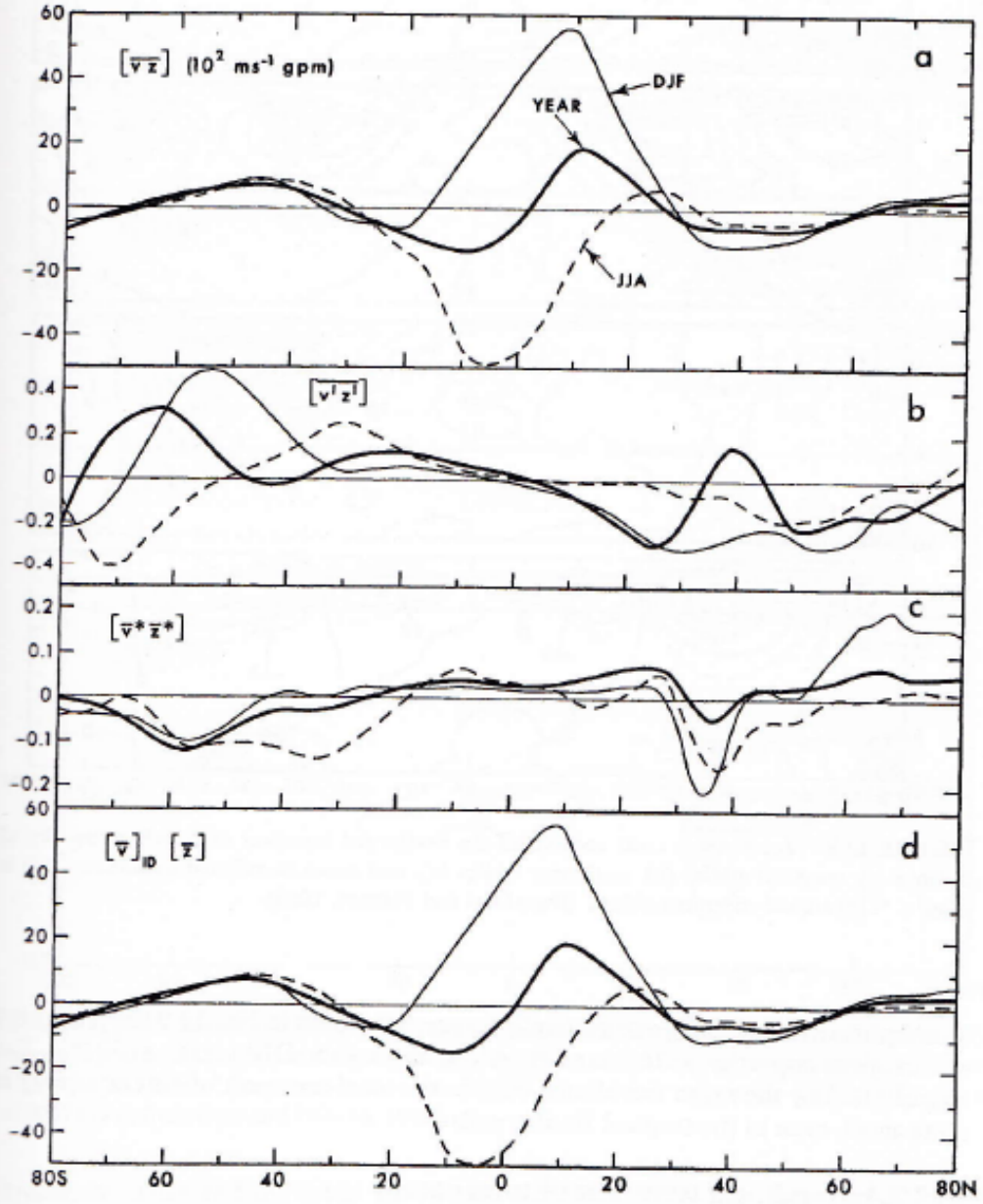


FIGURE 13.7. Meridional profiles of the zonal-and vertical-mean northward transport of potential energy by all motions (a), transient eddies (b), stationary eddies (c), and mean meridional circulations (d) in 10^2 gpm m s^{-1} [to convert to units of 10^{15} W multiply values by $2\pi R \cos\phi(p_0/g)$ or 0.4 $\cos\phi$; from Oort and Peixoto, 1983].

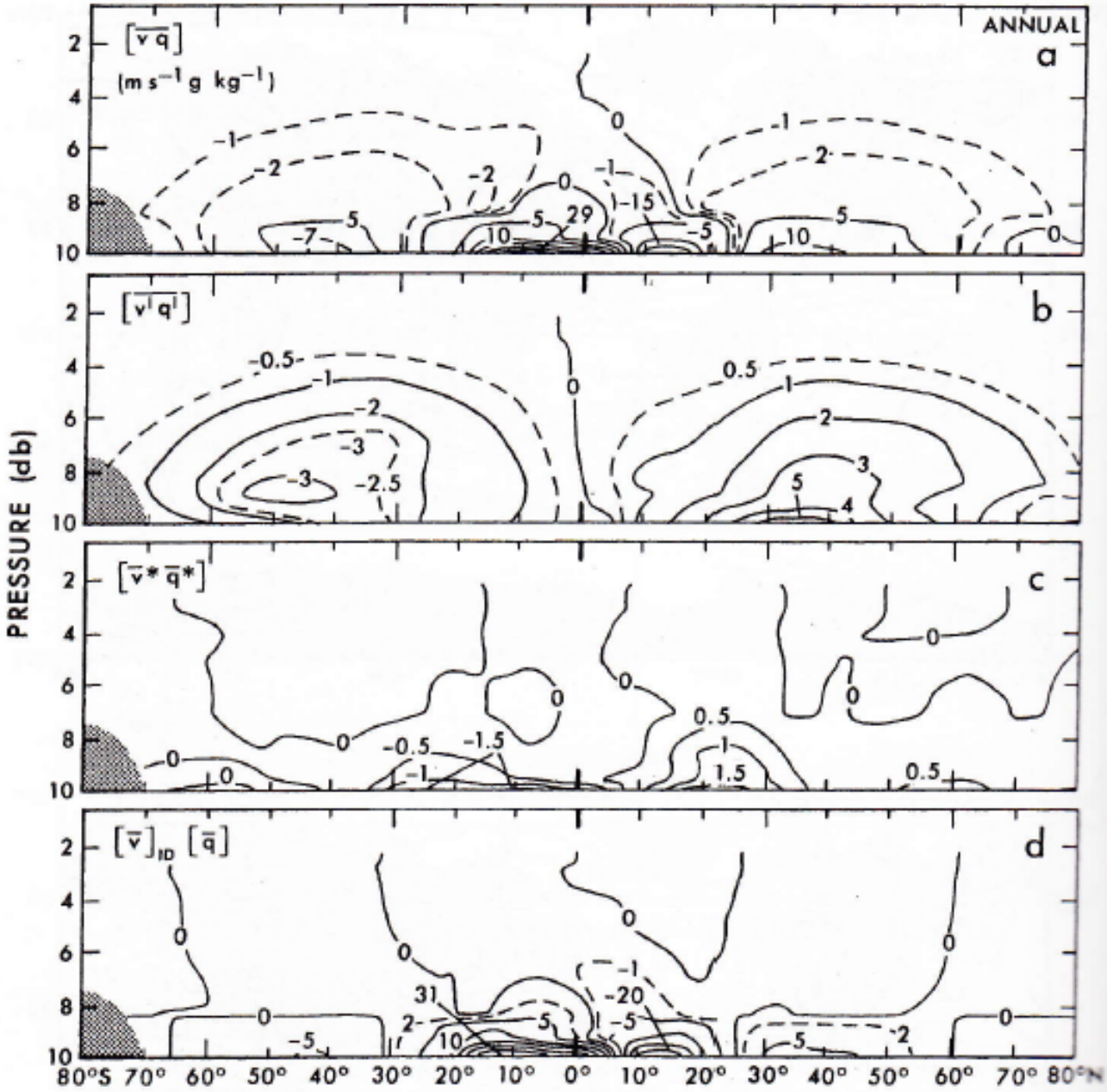


FIGURE 12.11. Zonal-mean cross sections of the northward transport of water vapor by all motions (a), transient eddies (b), stationary eddies (c), and mean meridional circulations (d) in m s^{-1} g kg^{-1} for annual-mean conditions.

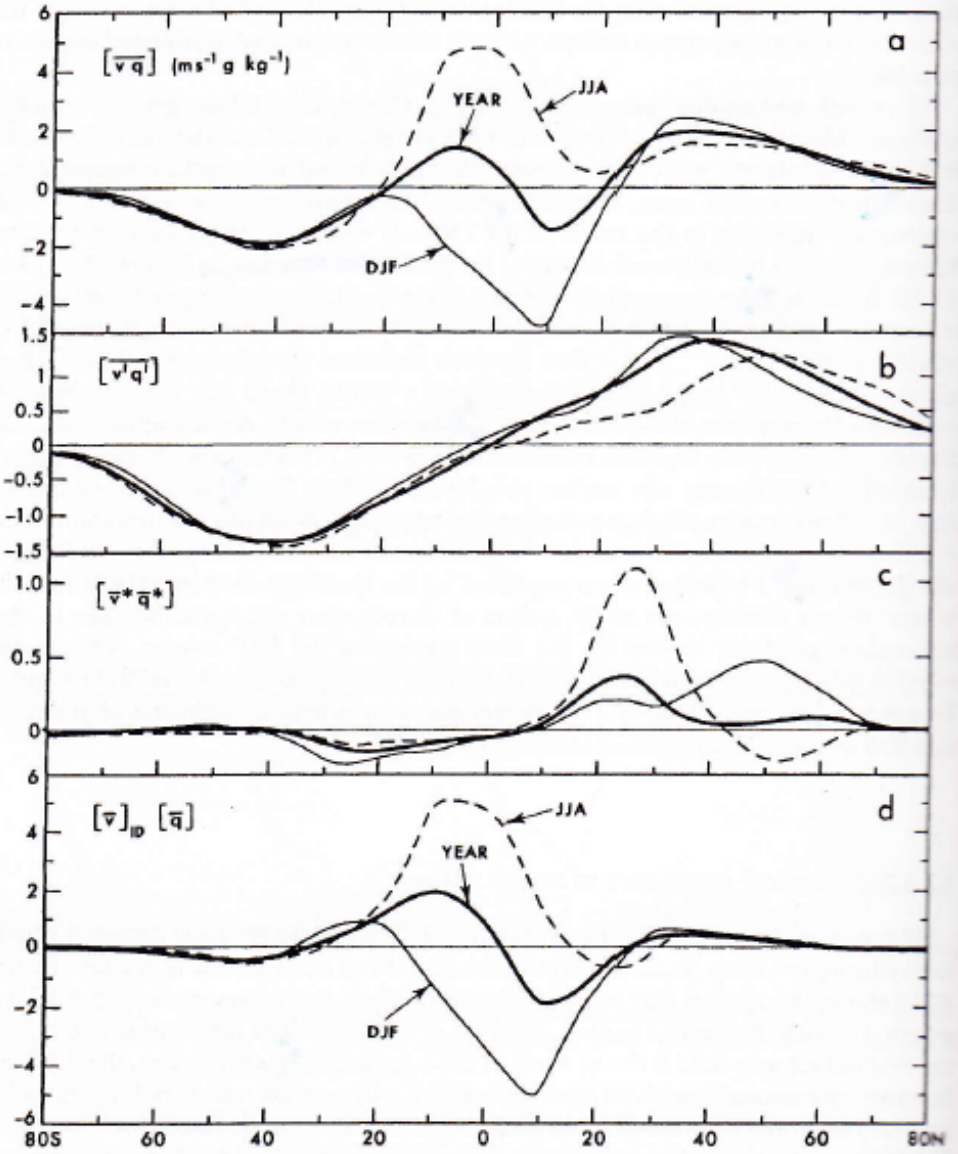


FIGURE 12.12. Meridional profiles of the vertical- and zonal-mean values of the northward transport of water vapor by all motions (a), transient eddies (b), stationary eddies (c), and mean meridional circulations (d) in m s^{-1} g kg^{-1} for annual, DJF, and JJA mean conditions. [To convert to total transport estimates multiply values by $10^{-3} 2\pi R \cos\phi\, p_0/g = 4 \cos\phi$ to find values in units of 10^8 kg s^{-1} or by 12.6 $\cos\phi$ to find units in 10^{15} kg yr^{-1}, where $2\pi R \cos\phi$ = length of latitude circle and $p_0/g = 10^4$ kg m^{-2} the total atmospheric mass per unit area.] (After Peixoto and Oort, 1983).

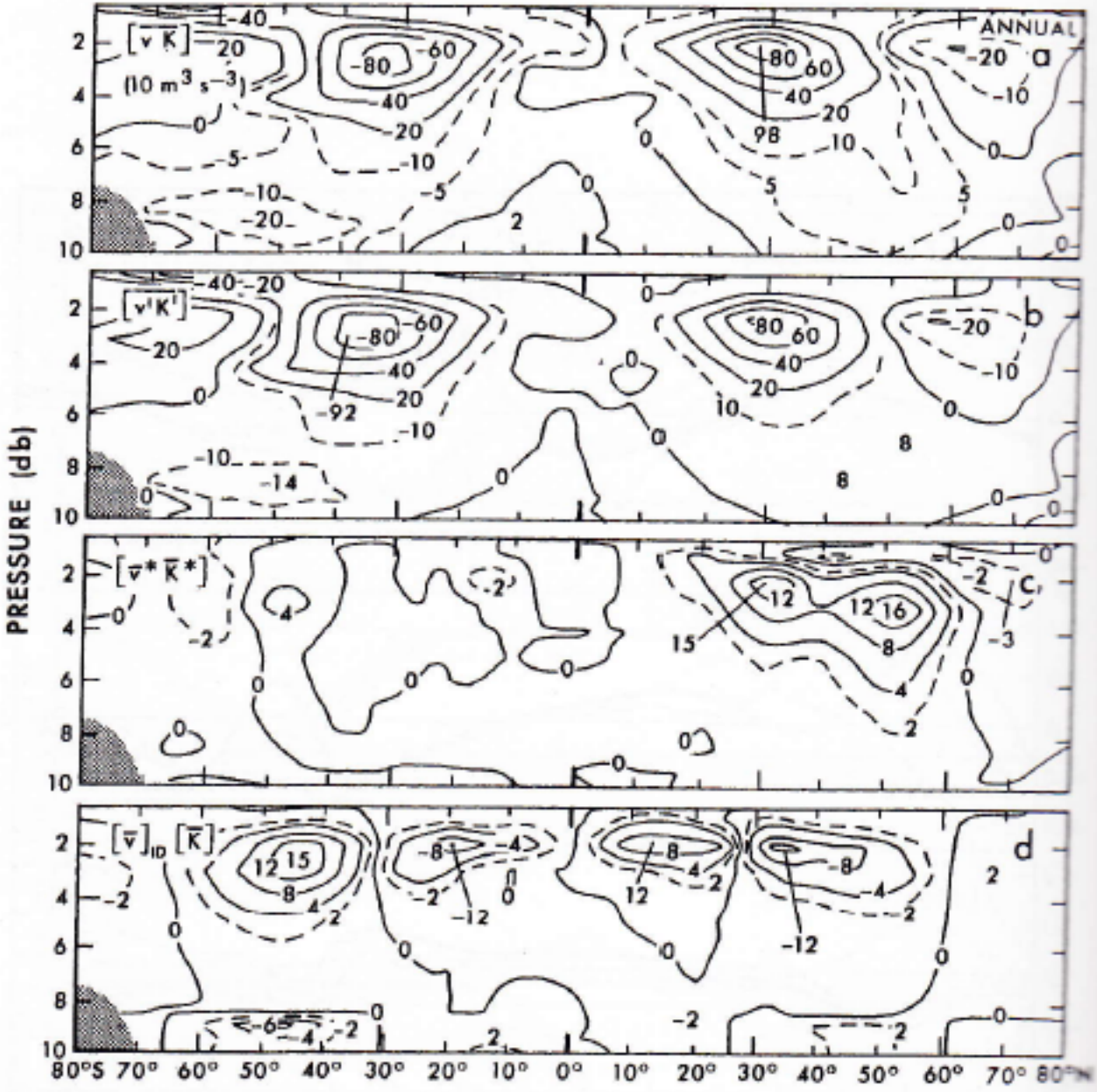


FIGURE 13.8. Zonal-mean cross sections of the northward transport of kinetic energy by all motions (a), transient eddies (b), stationary eddies (c), and mean meridional circulations (d) in $10\ m^3\ s^{-3}$ for annual-mean conditions (from Oort and Peixoto, 1983).

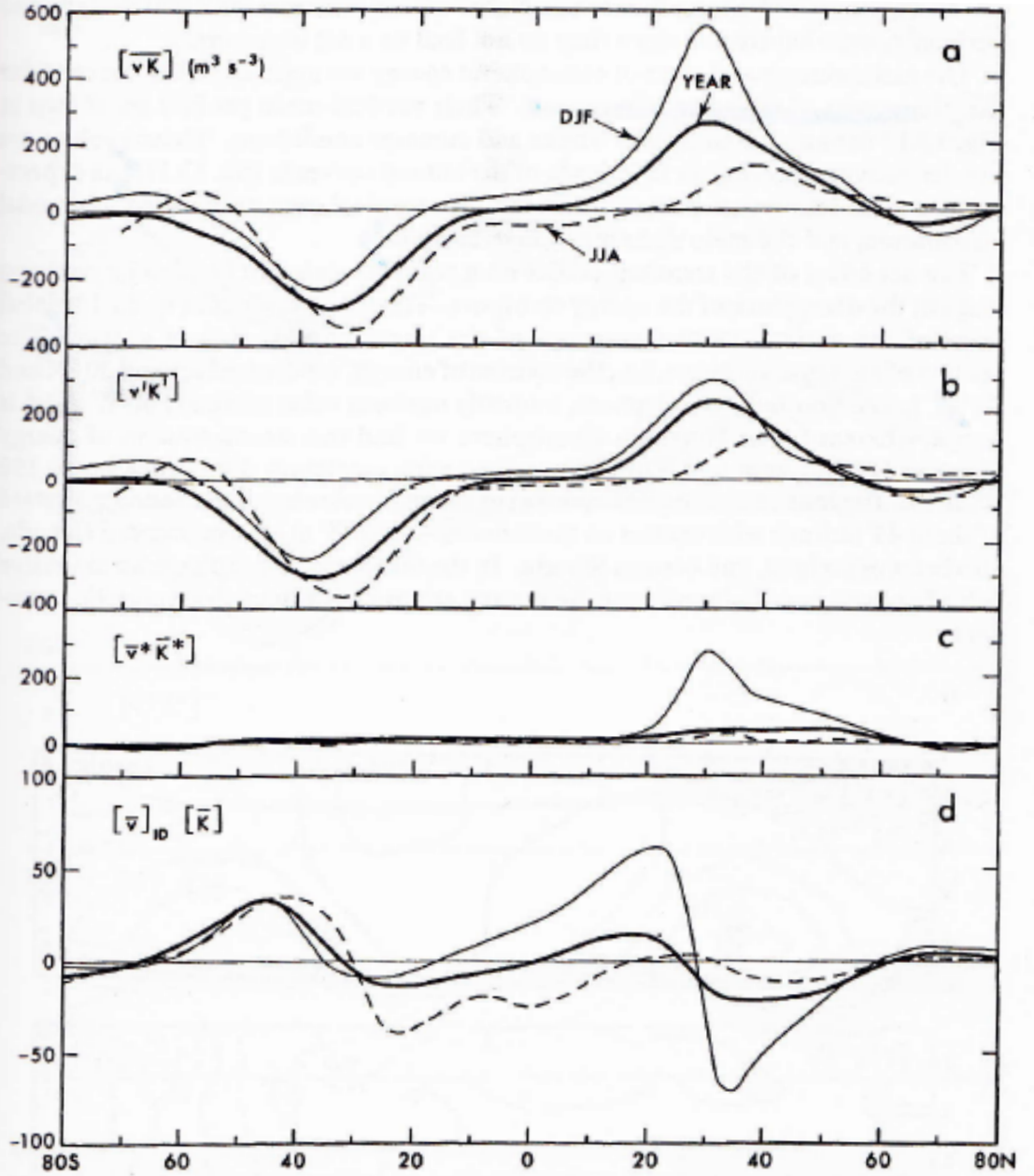


FIGURE 13.9. Meridional profiles of the zonal-and vertical-mean northward transport of kinetic energy by all motions (a), transient eddies (b), stationary eddies (c), and mean meridional circulations (d) in $m^3\,s^{-3}$ [to convert to units of 10^{15} W multiply values by $2\pi R \cos\phi(p_0/g)$ or $0.0004 \cos\phi$; from Oort and Peixoto, 1983].

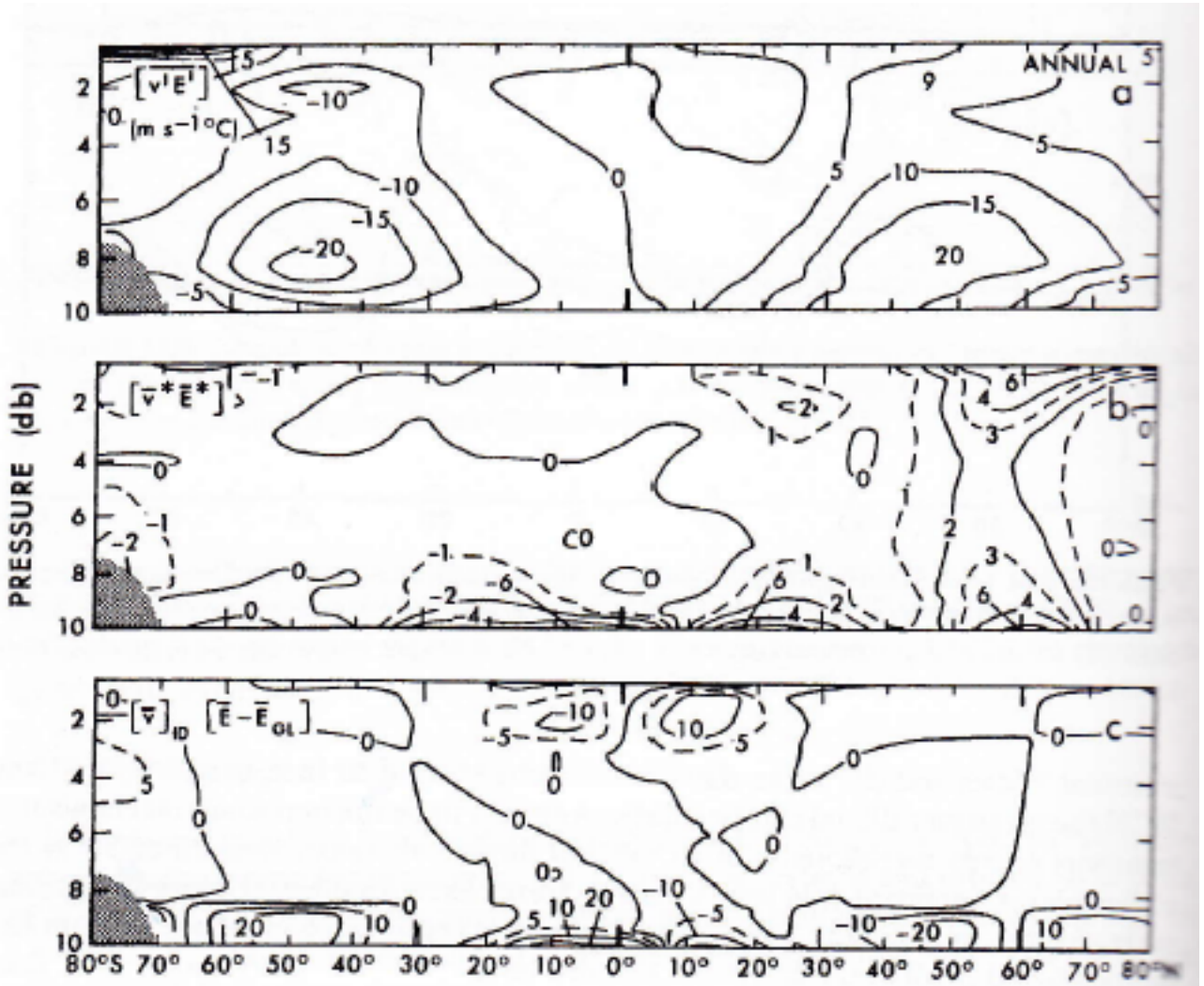
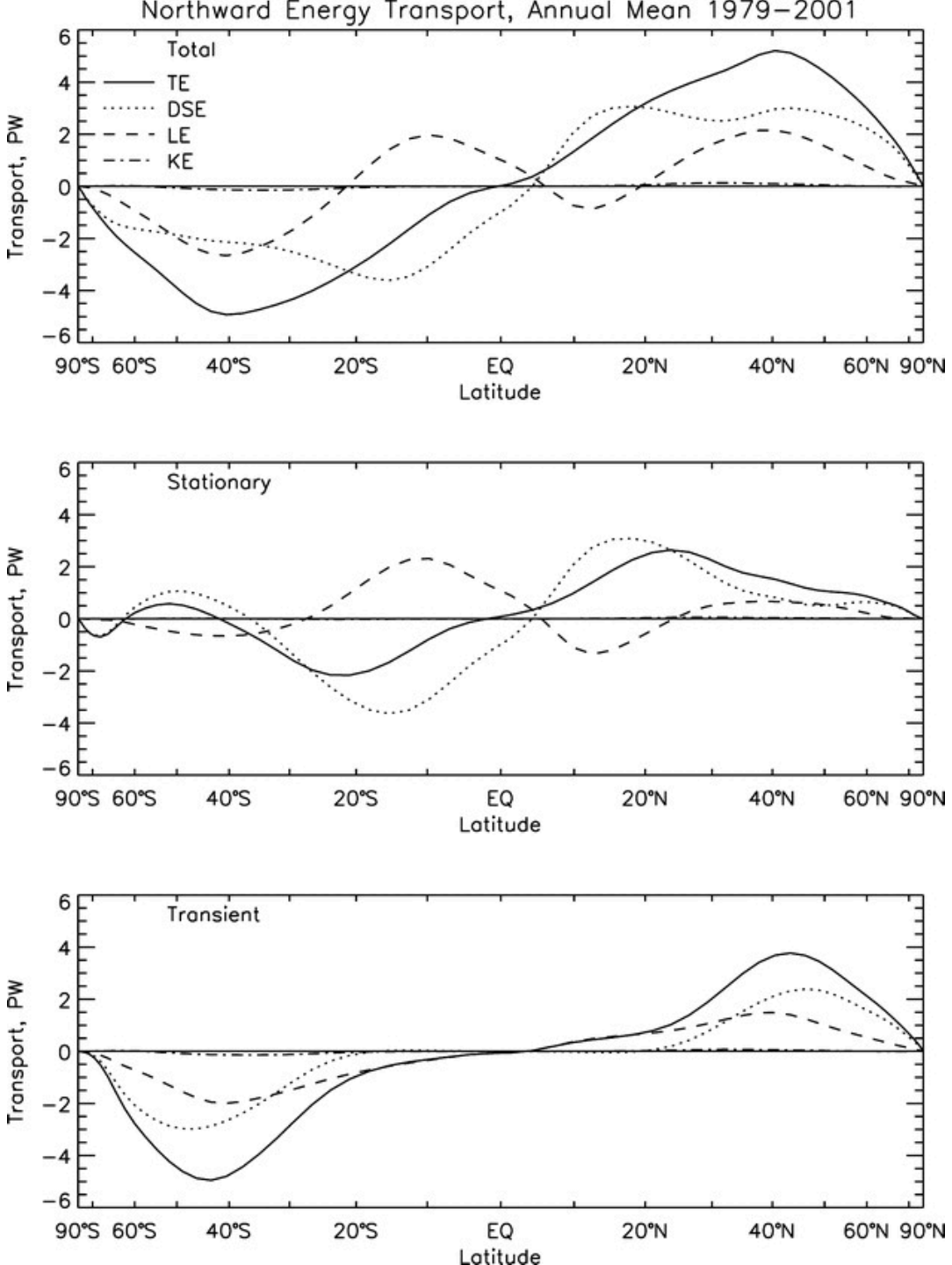
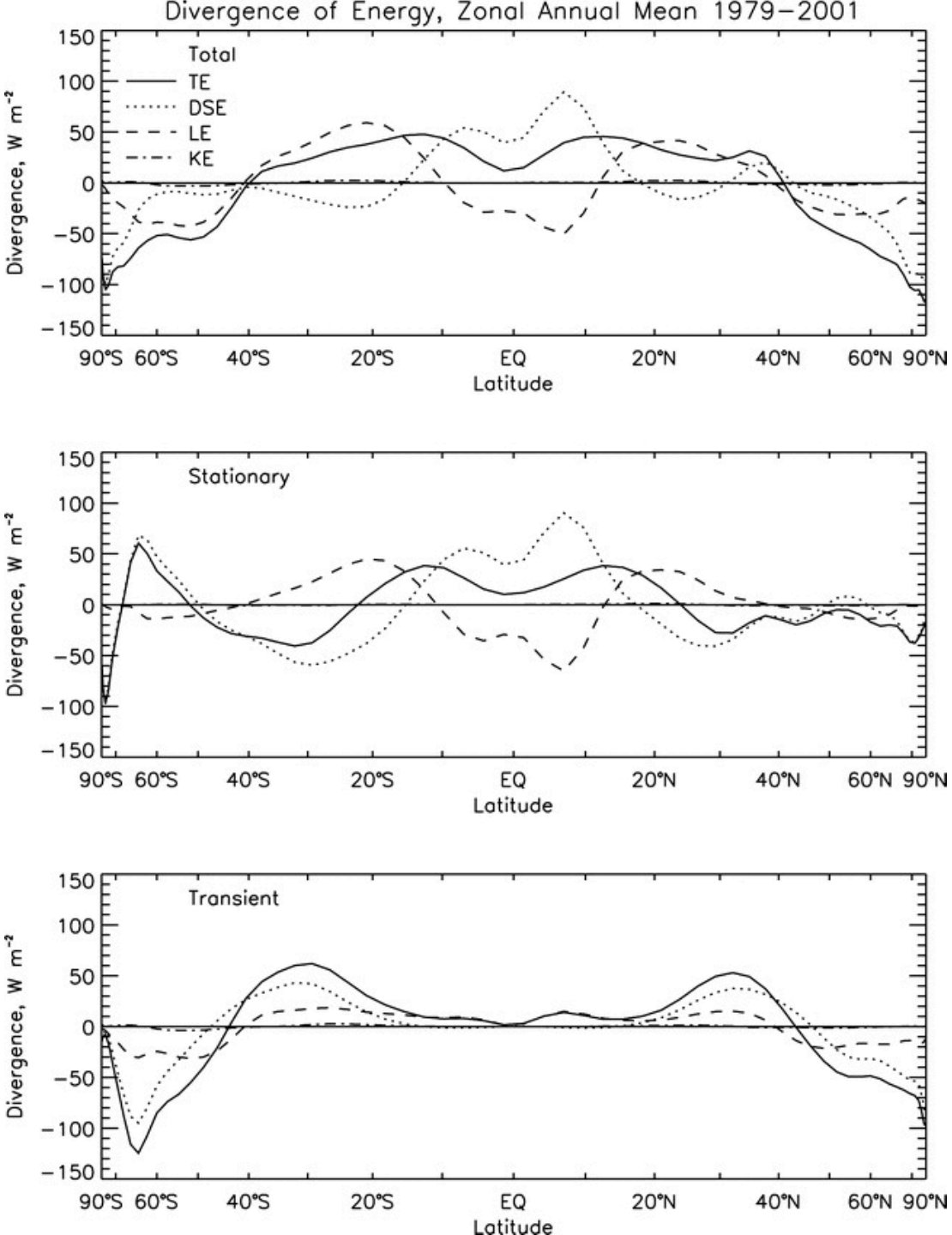


FIGURE 13.10. Zonal-mean cross sections of the northward transport of total energy by transient eddies (a), stationary eddies (b), and mean meridional circulations (c) for annual-mean conditions in °C m s^{-1} (from Oort and Peixoto, 1983).

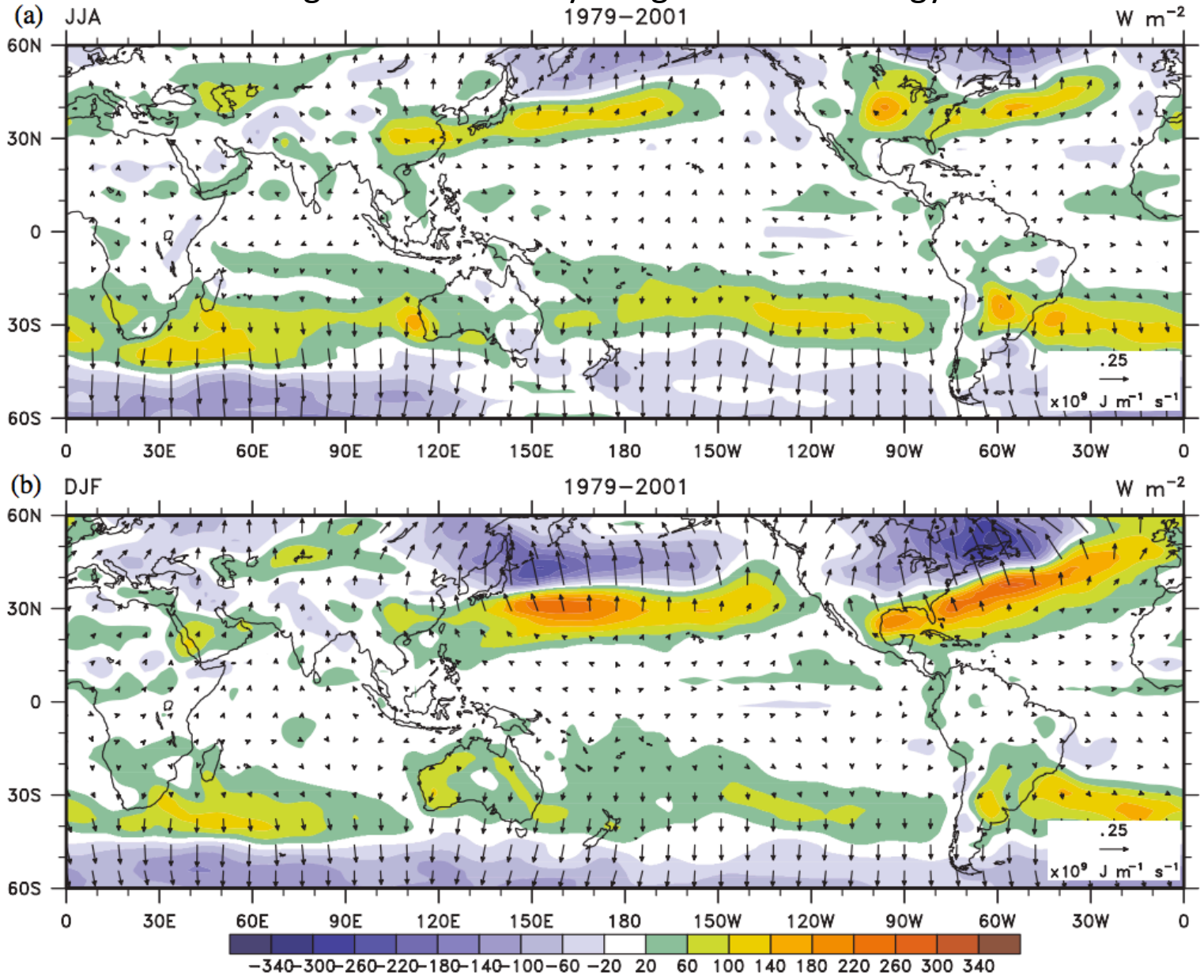


Trenberth and Stepaniak (2003)

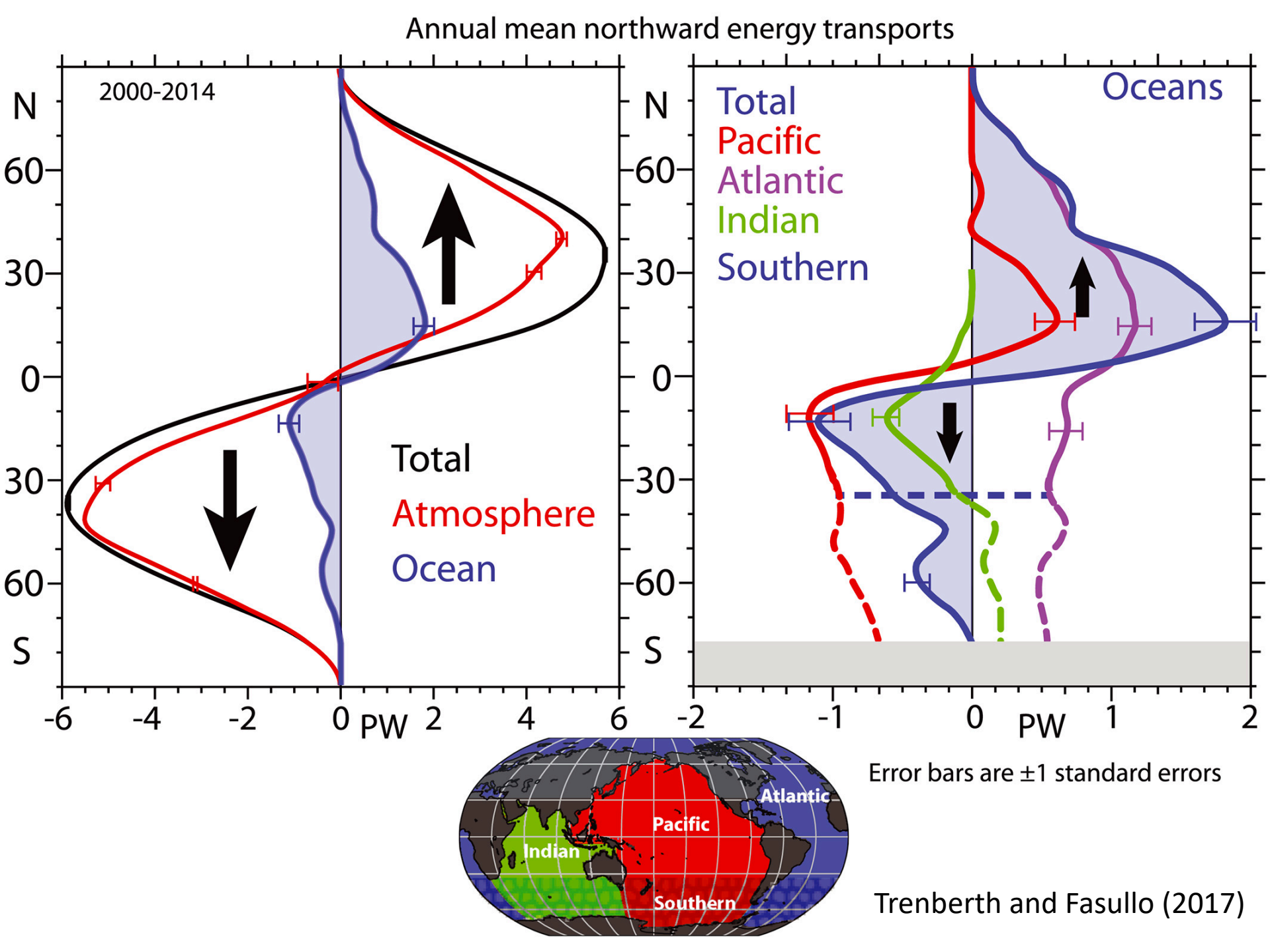


Trenberth and Stepaniak (2003)

Divergence of vertically integrated total energy flux



Trenberth and Stepaniak (2004)


Annual mean northward energy transports
2000-2014
N
60
30
0
30
60
S
-6
-4
-2
0
2
4
6
PW
Total
Atmosphere
Ocean
Oceans
Total
Pacific
Atlantic
Indian
Southern
-2
-1
0
1
2
PW
Error bars are ±1 standard errors
Atlantic
Pacific
Indian
Southern
Trenberth and Fasullo (2017)

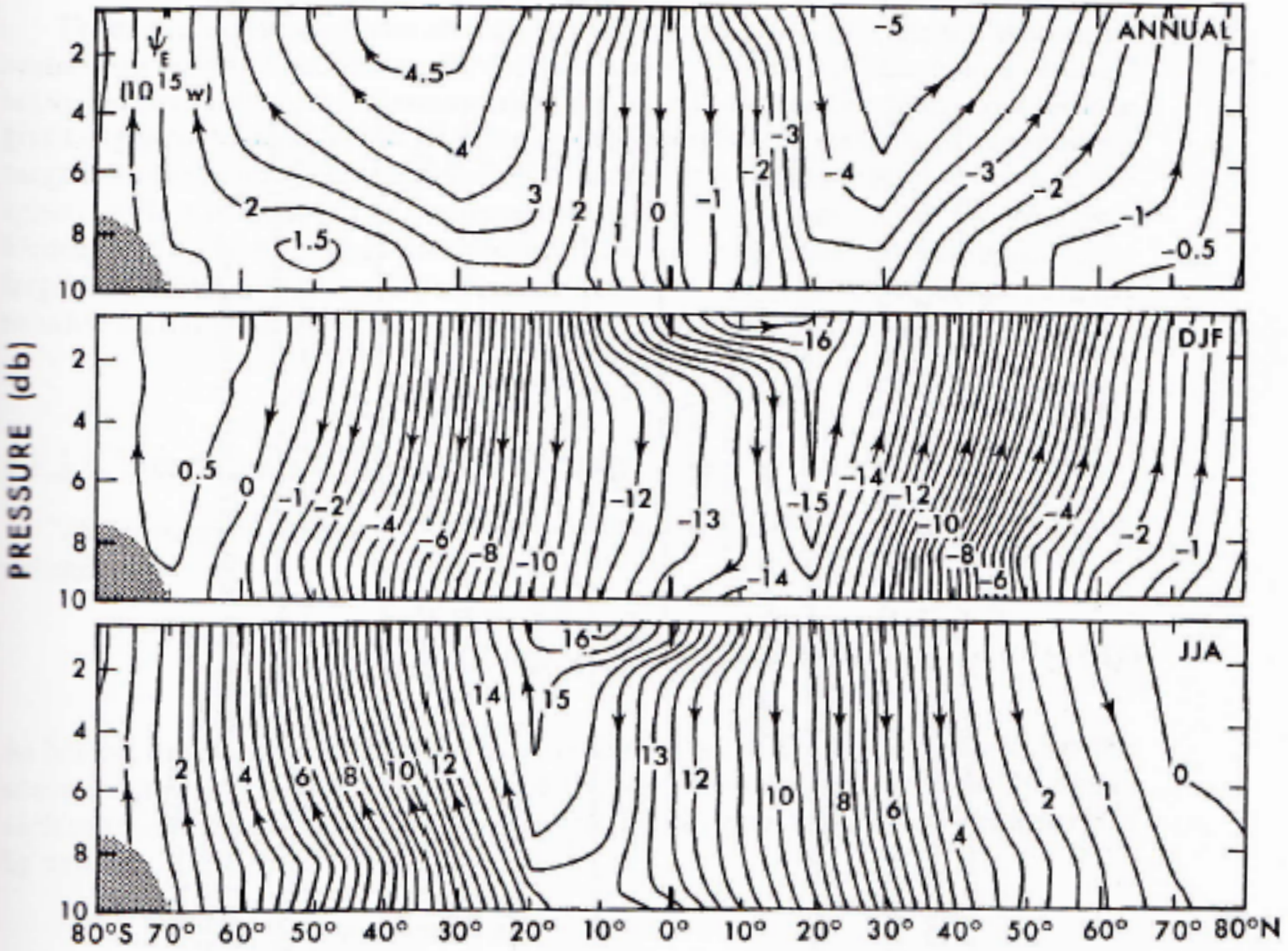


FIGURE 13.15. Streamlines of the zonal-mean transport of total energy in the atmosphere for annual, DJF, and JJA mean conditions in 10^{15} W (from Oort and Peixoto, 1983).

Lorenz Energy Cycle

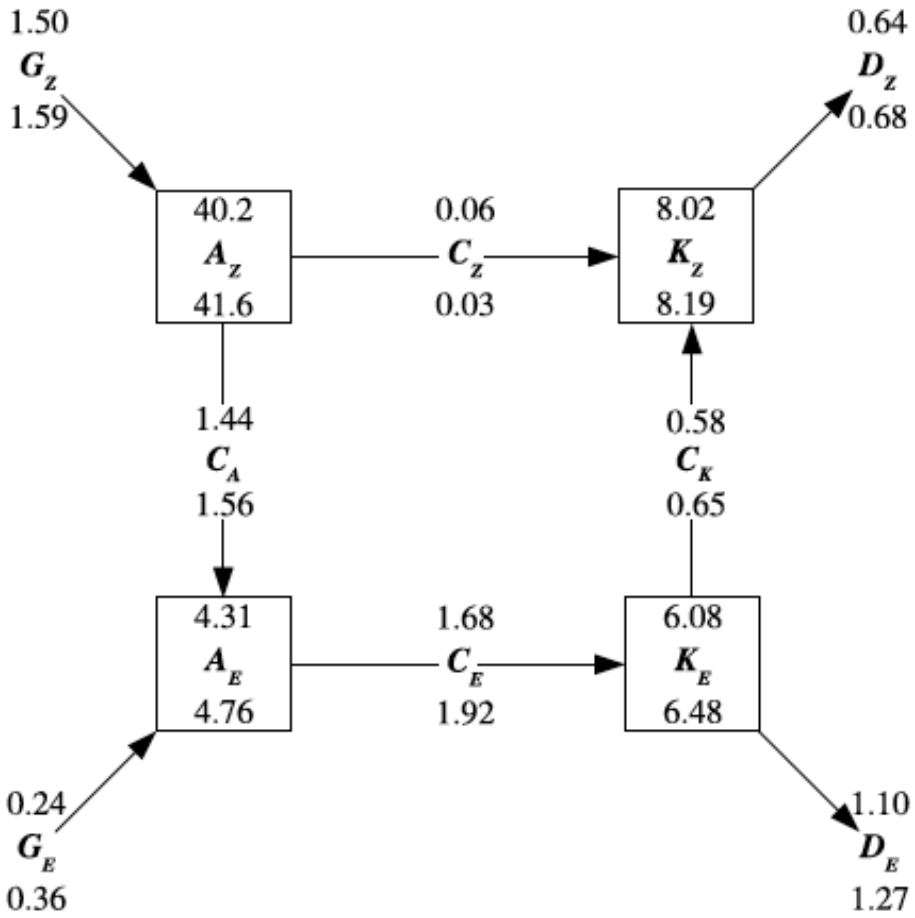


Figure 1. Energy cycle diagram averaged over 1979–2001 for NCEP (top values) and ECMWF (bottom values) Reanalyses. Energy amounts in units of 10^5 J m^{-2} and transformation rates in W m^{-2}.

Marques et al. (2008)

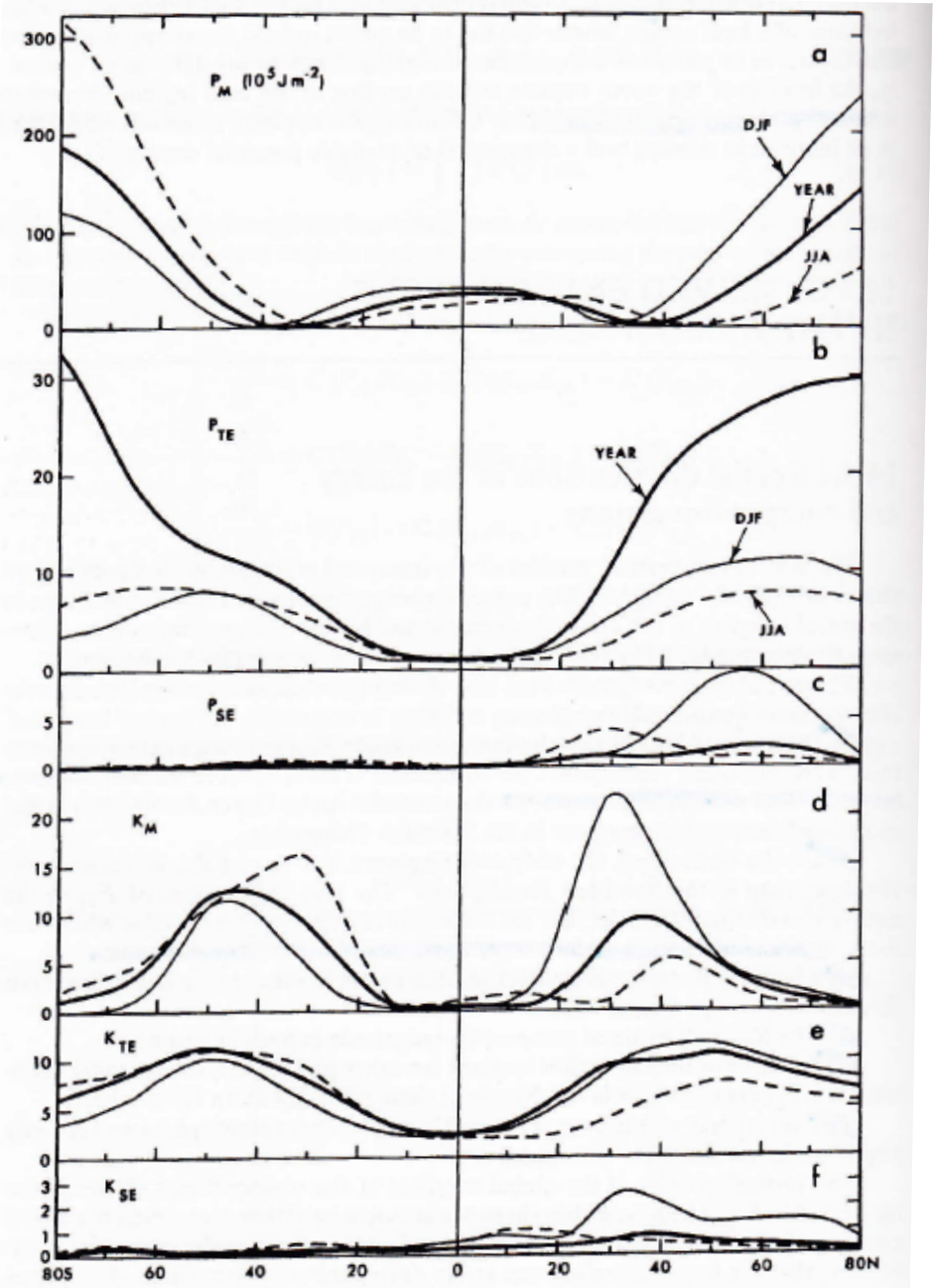


FIGURE 14.4. Meridional profiles of the contributions to the global integrals of the mean available potential energy (a), transient eddy available potential energy (b), stationary eddy available potential energy (c), mean kinetic energy (d), transient eddy kinetic energy (e), and stationary eddy kinetic energy (f) in the atmosphere in units of 10^5 J m^{-2} (from Oort and Peixoto, 1983).

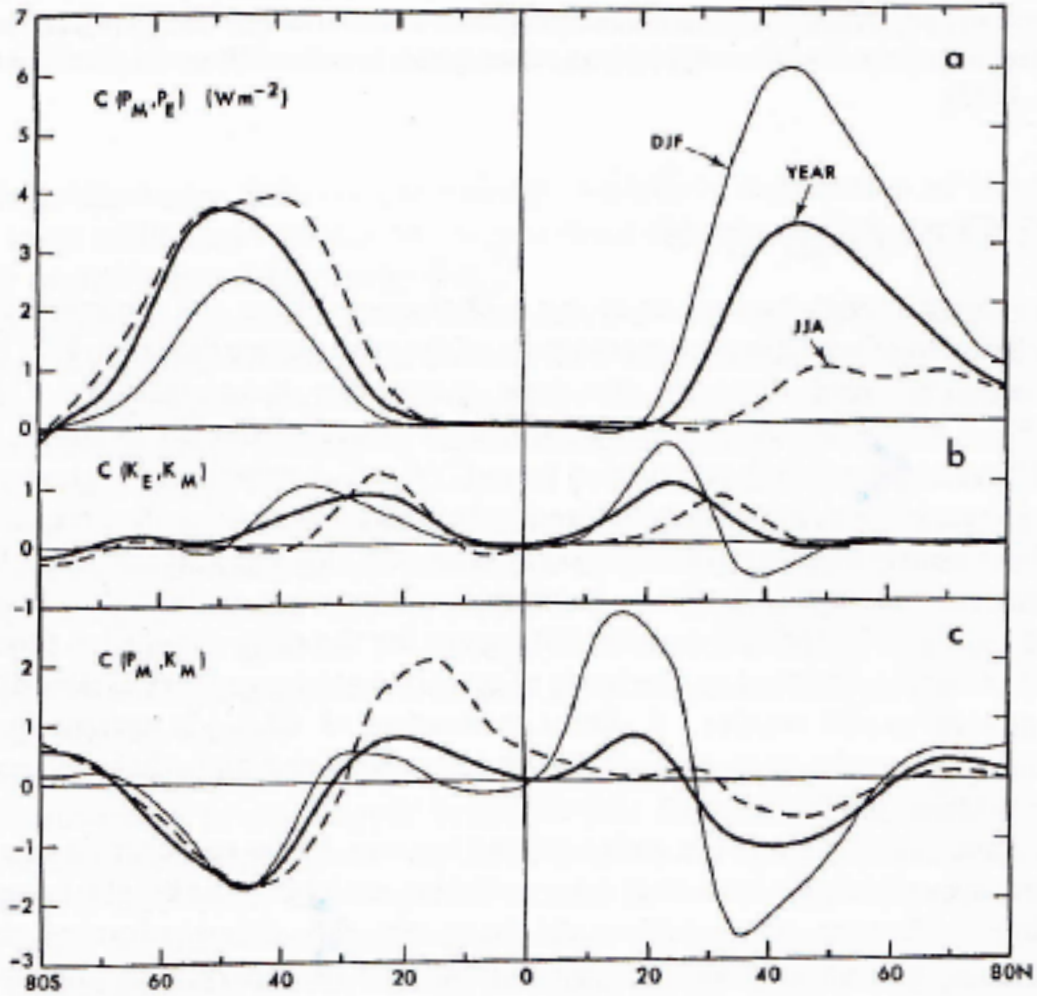


FIGURE 14.6. Meridional profiles of the contributions to the global integrals of the conversion rates from mean to eddy available potential energy (a), eddy to mean kinetic energy (b), and mean available potential to mean kinetic energy (c) in the atmosphere in units of W m^{-2} (from Oort and Peixoto, 1983).