Section 3: Mean state and variability of the atmosphere

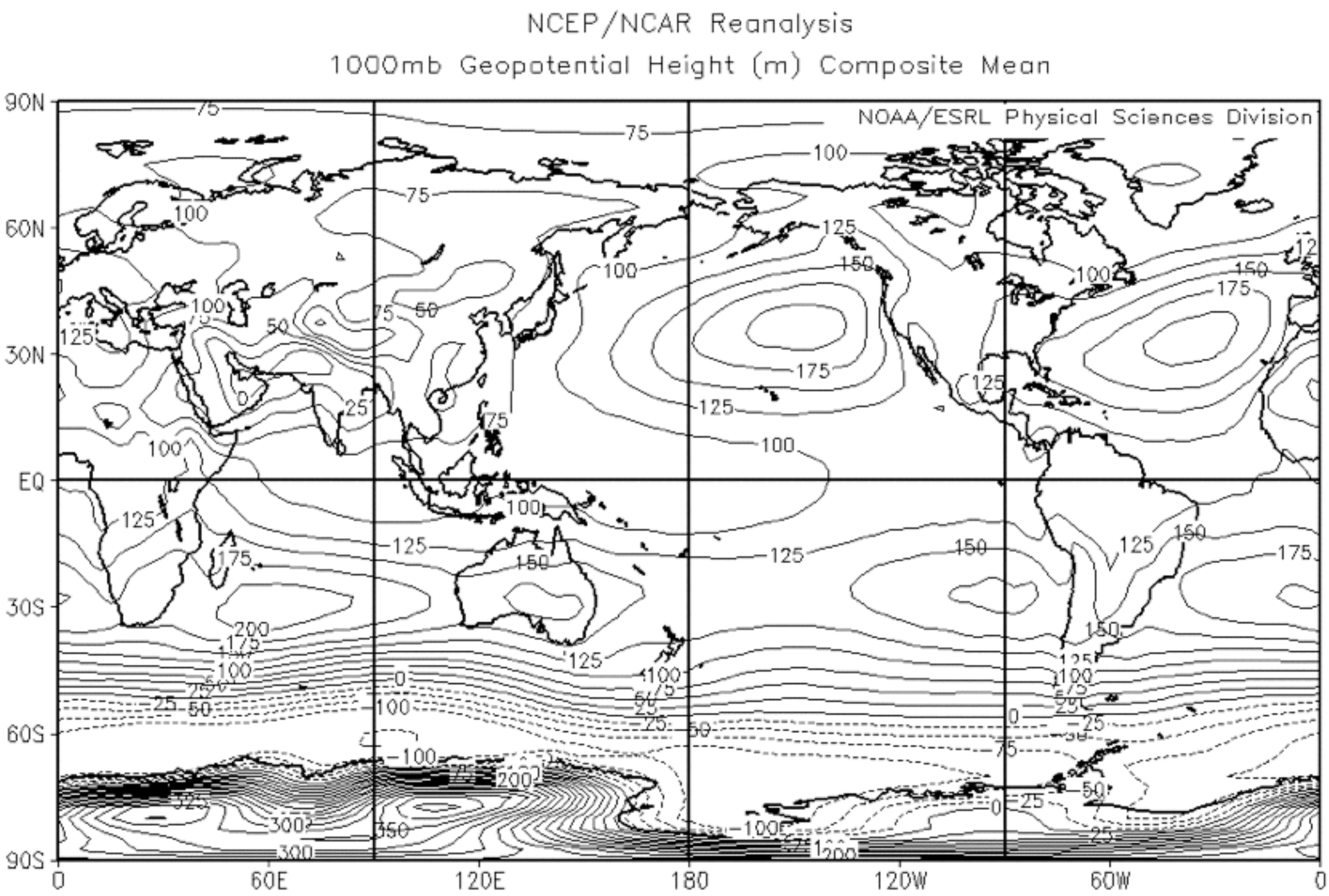
- Develop intuition and familiarity with current state of general circulation

- State variables of this thermo-hydrodynamical system: T, p, q, u,v,w

- Consider distribution of mass, thermal structure, circulations, and distribution of moisture

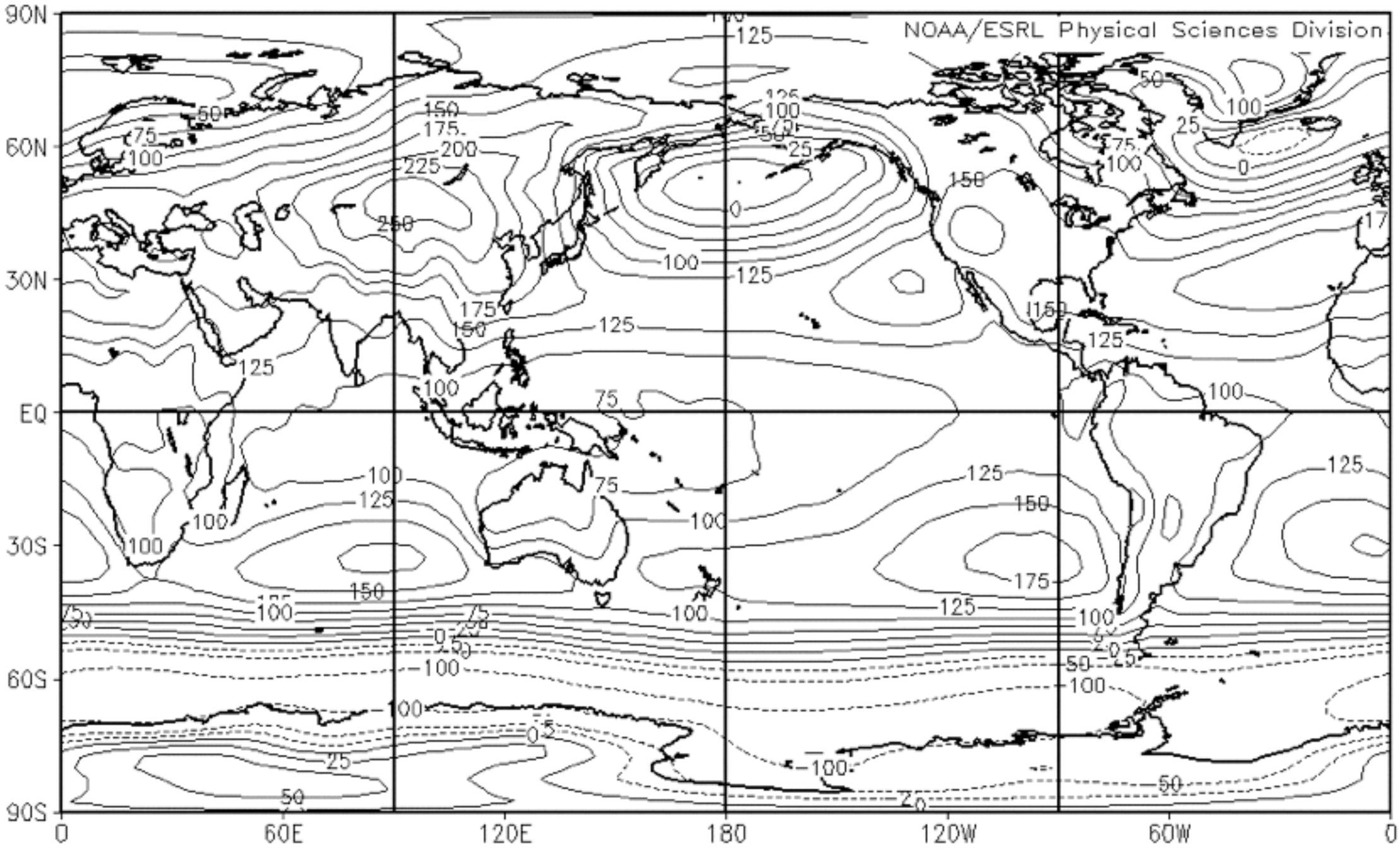
Distribution of mass

Geopotential height at 1000hPa: JJA



Climate Diagnostics Center interactive plotting site

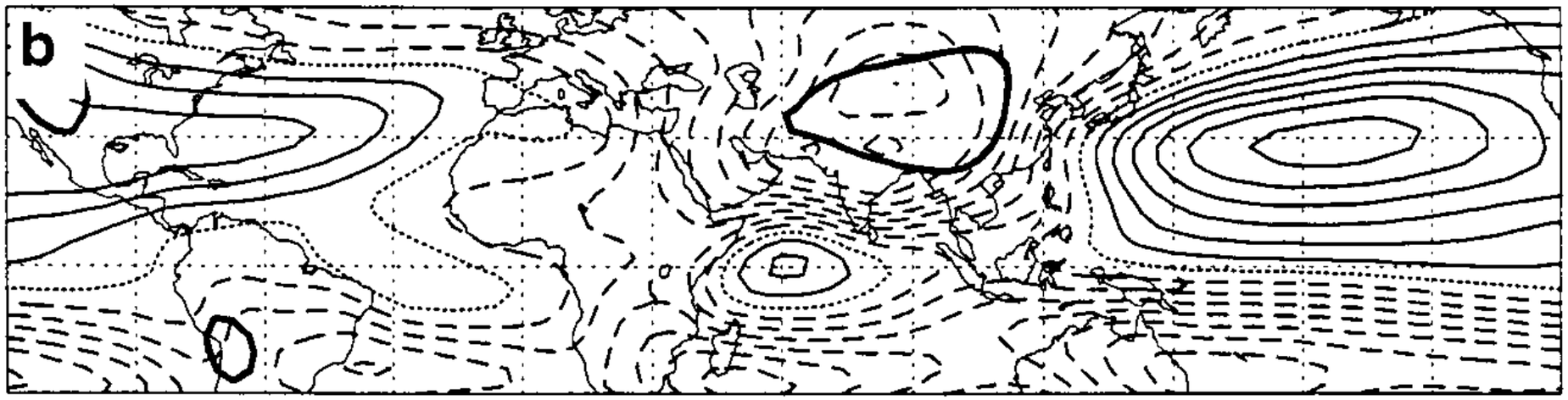
Geopotential height at 1000hPa: DJF



Climate Diagnostics Center interactive plotting site

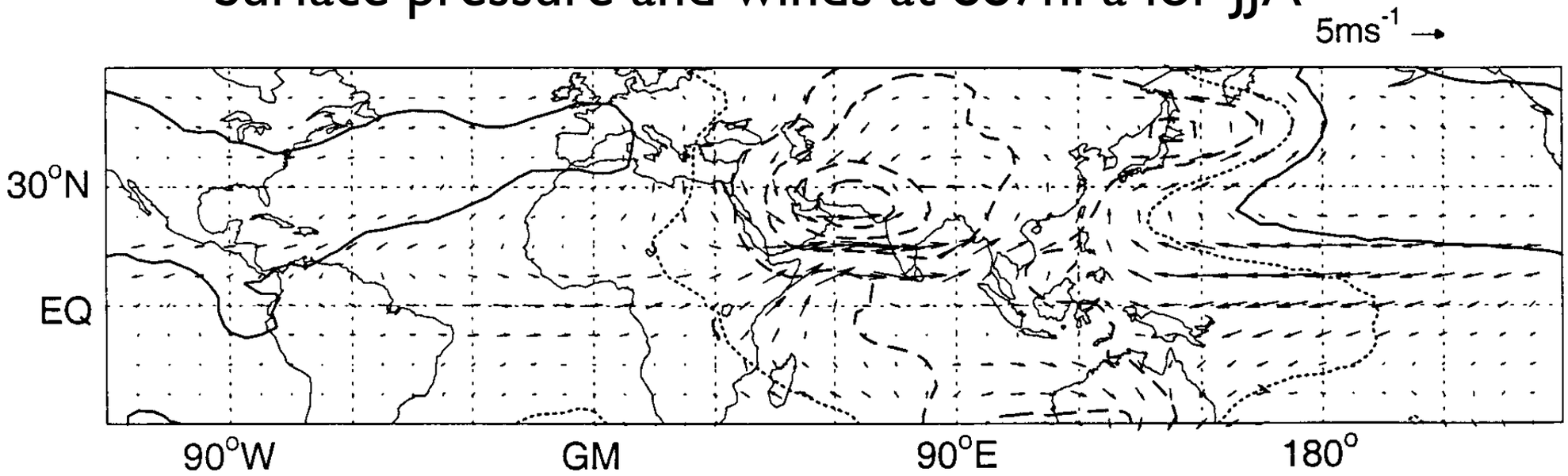
Subtropical highs are response to monsoon heating and to orography

Horizontal streamfunction at 887hPa for JJA



Response to mountains and Asian diabatic heating

Surface pressure and winds at 887hPa for JJA



Response to Asian diabatic heating

Rodwell and Hoskins 2001
Thick line shows intersection of 887hPa with orography

Zonal-mean sea level pressure

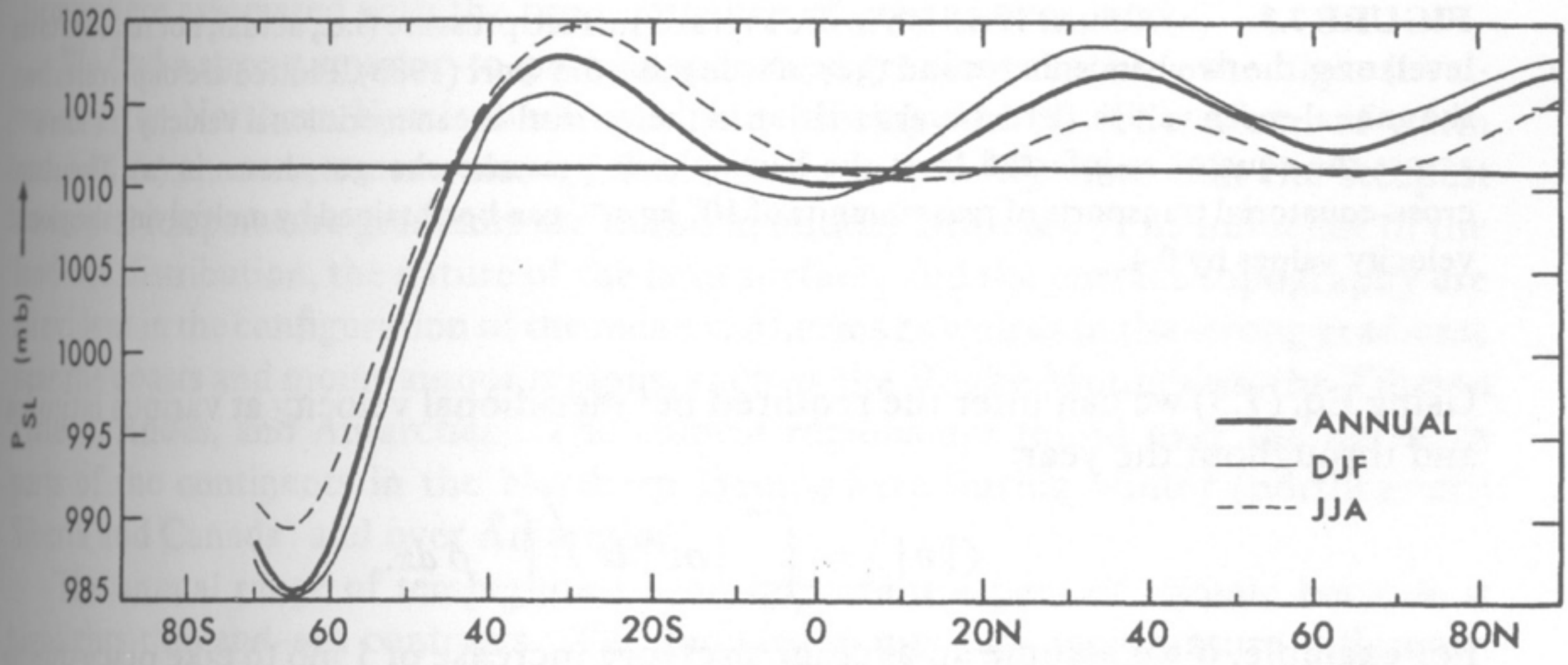
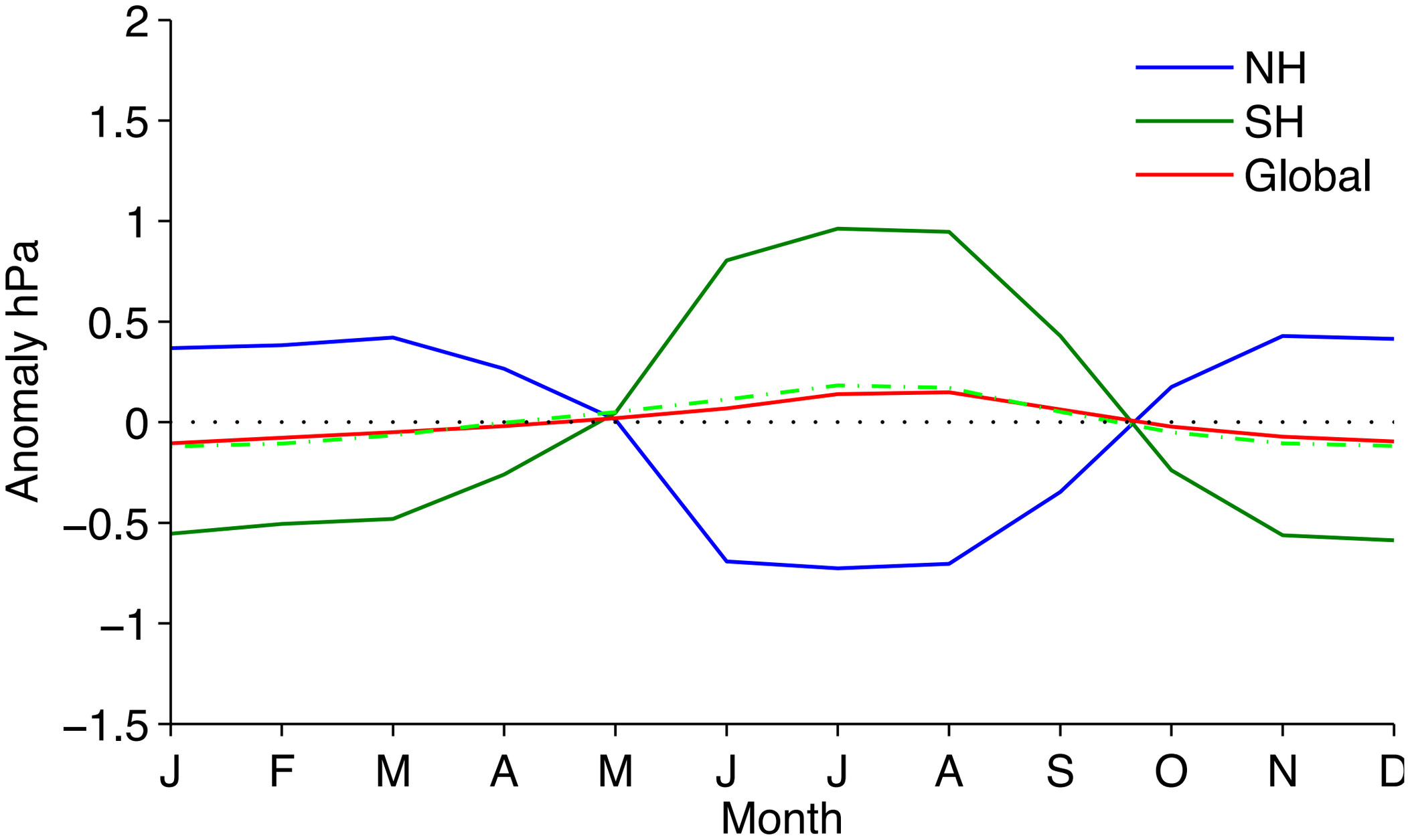


FIGURE 7.2. Meridional profiles of the zonal-mean sea level pressure for annual-mean conditions after Trenberth (1981) and for the DJF and JJA seasons after Oort (1983) in mb.

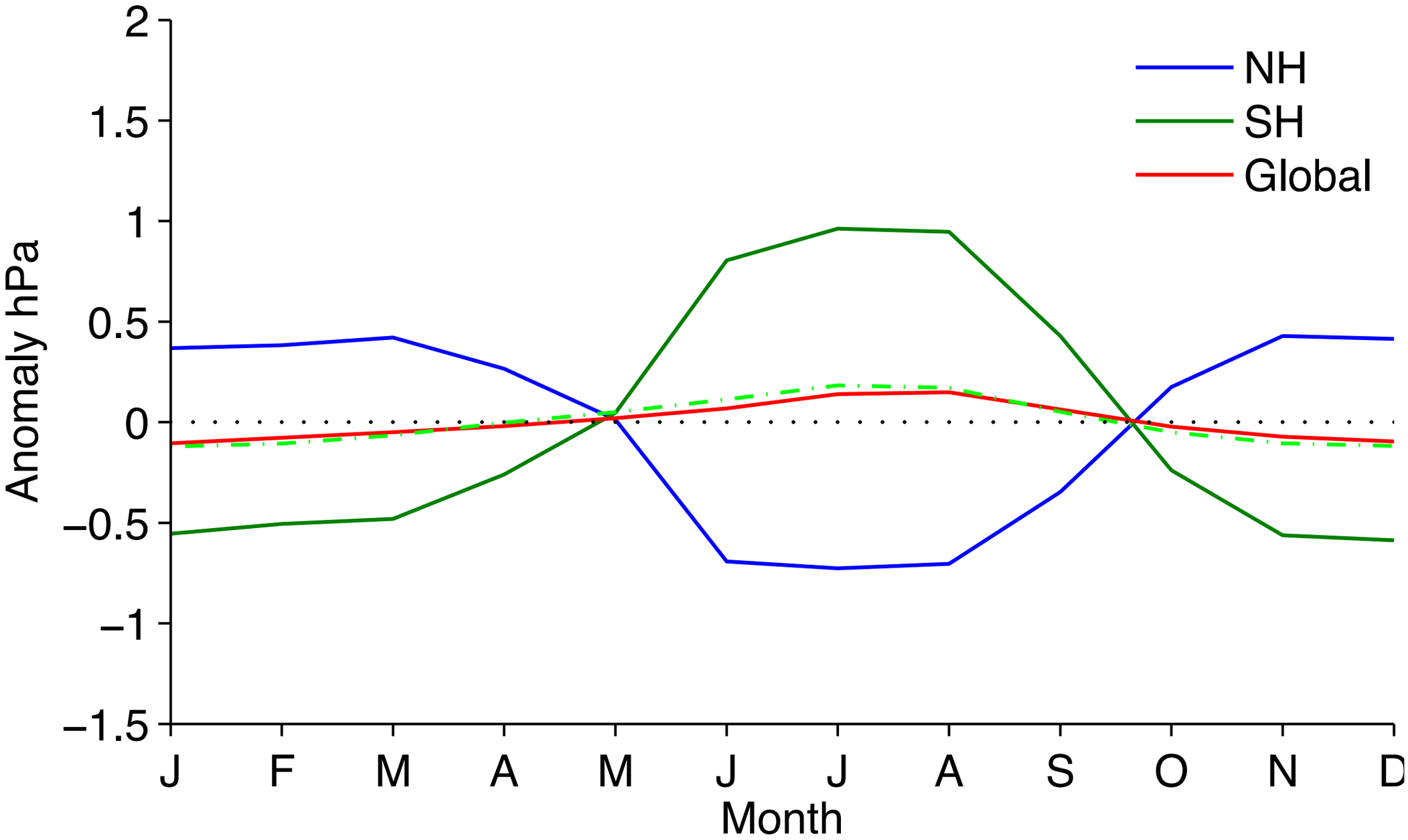
Peixoto and Oort, fig 7.2

Seasonal cycle of hemispheric mass as represented by anomalies in hemispheric-mean surface pressure



ERA 40 reanalysis data 1980-2001; cf. Trenberth et al, JGR 1982, 92, 14815-14826

Seasonal cycle of hemispheric mass as represented by anomalies in hemispheric-mean surface pressure

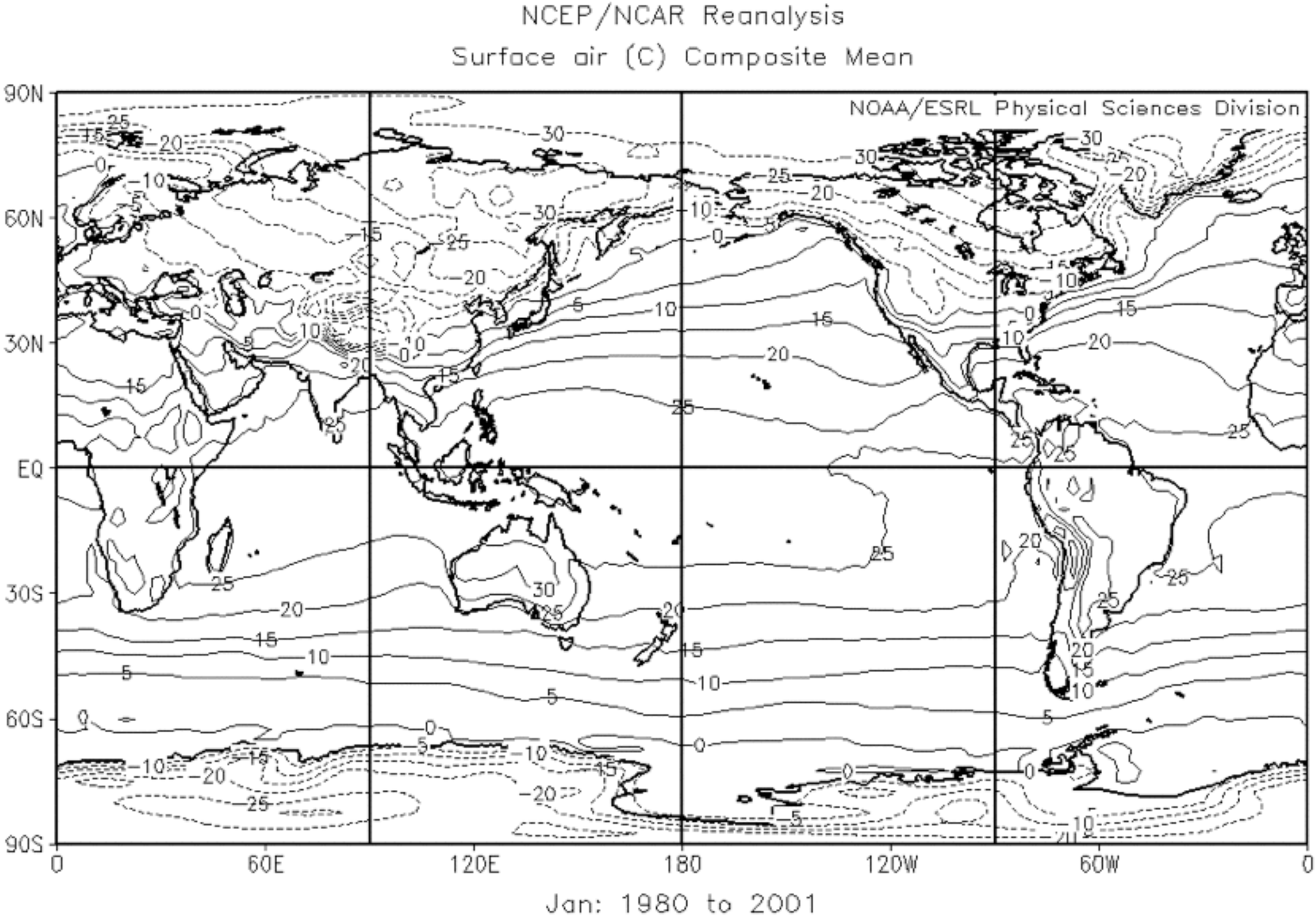


ERA 40 reanalysis data 1980-2001; cf. Trenberth et al, JGR 1982, 92, 14815-14826

Green dash-dotted: global-mean mass of water vapor multiplied by g

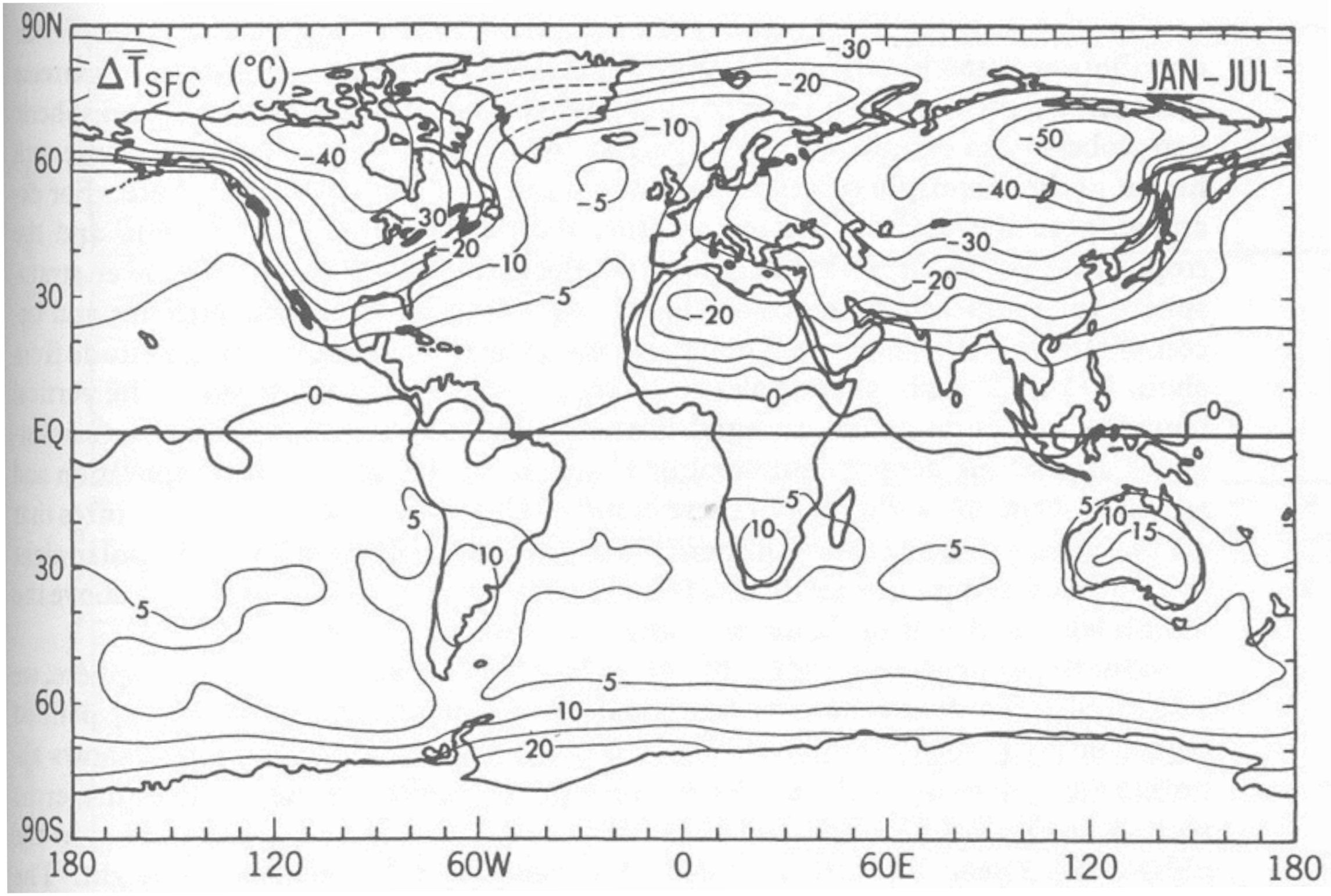
Thermal structure

Surface air temperature: January



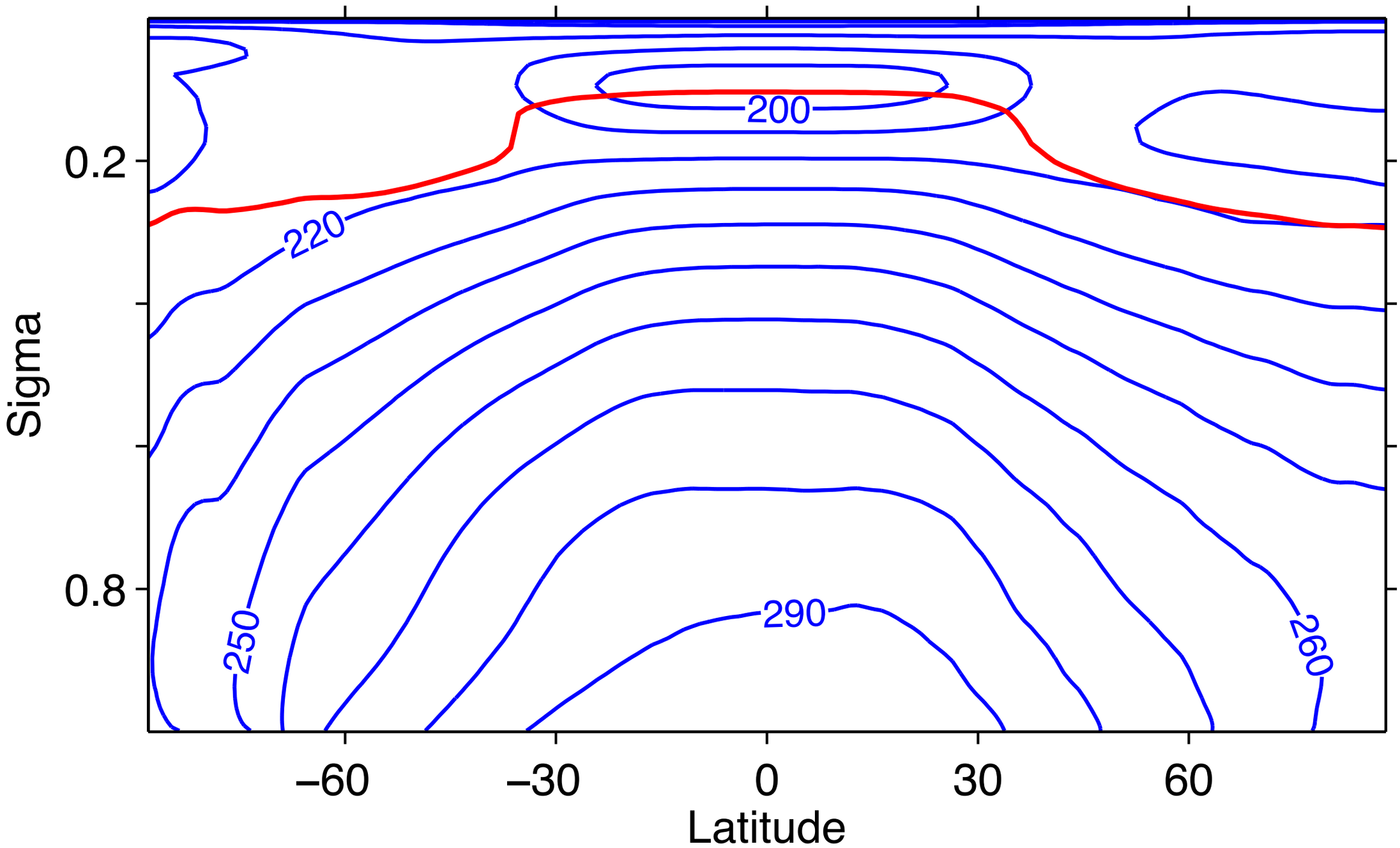
Climate Diagnostics Center interactive plotting site

Surface air temperature: January-July



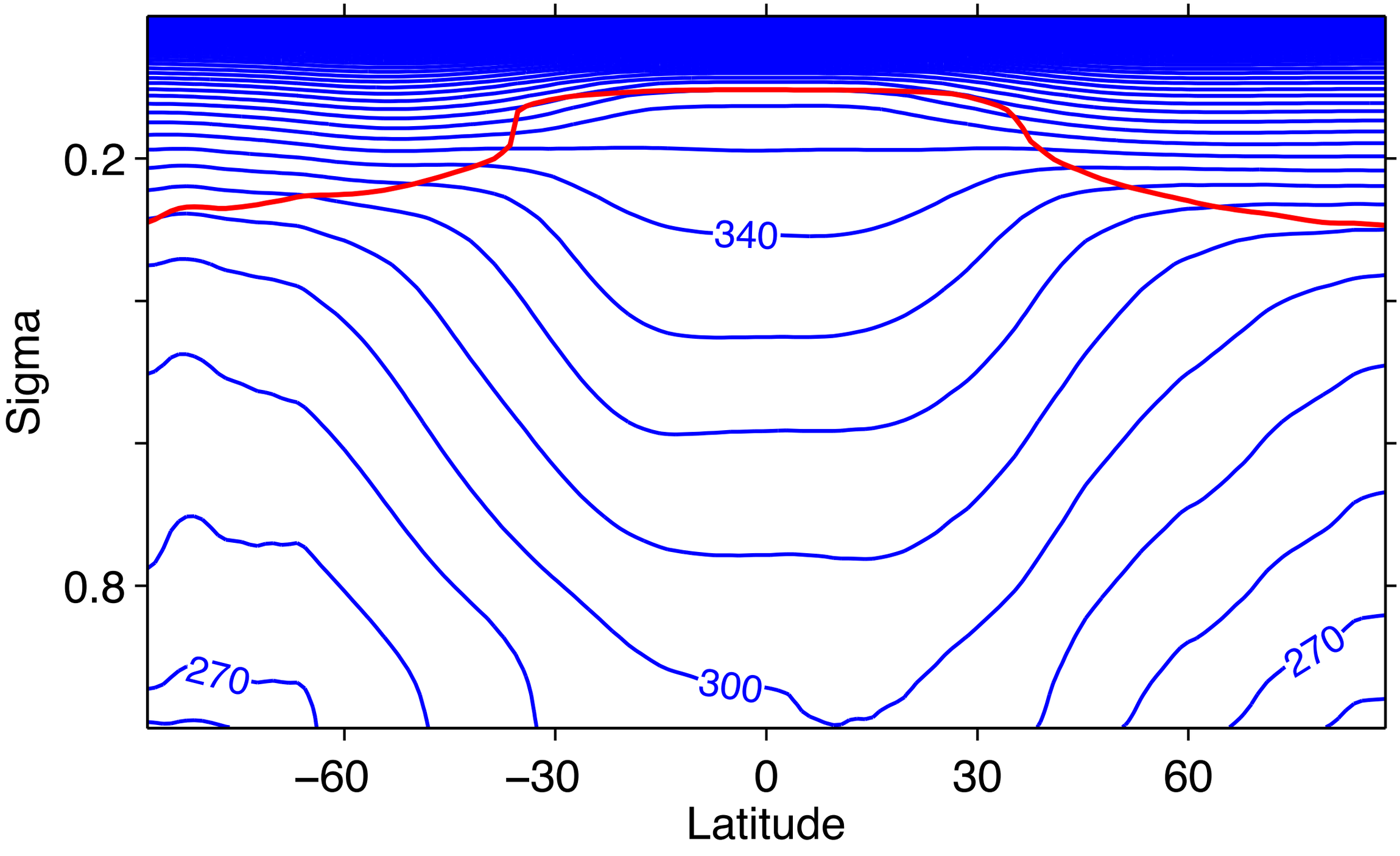
Peixoto and Oort

Zonal and time mean temperature (K) (annual average)



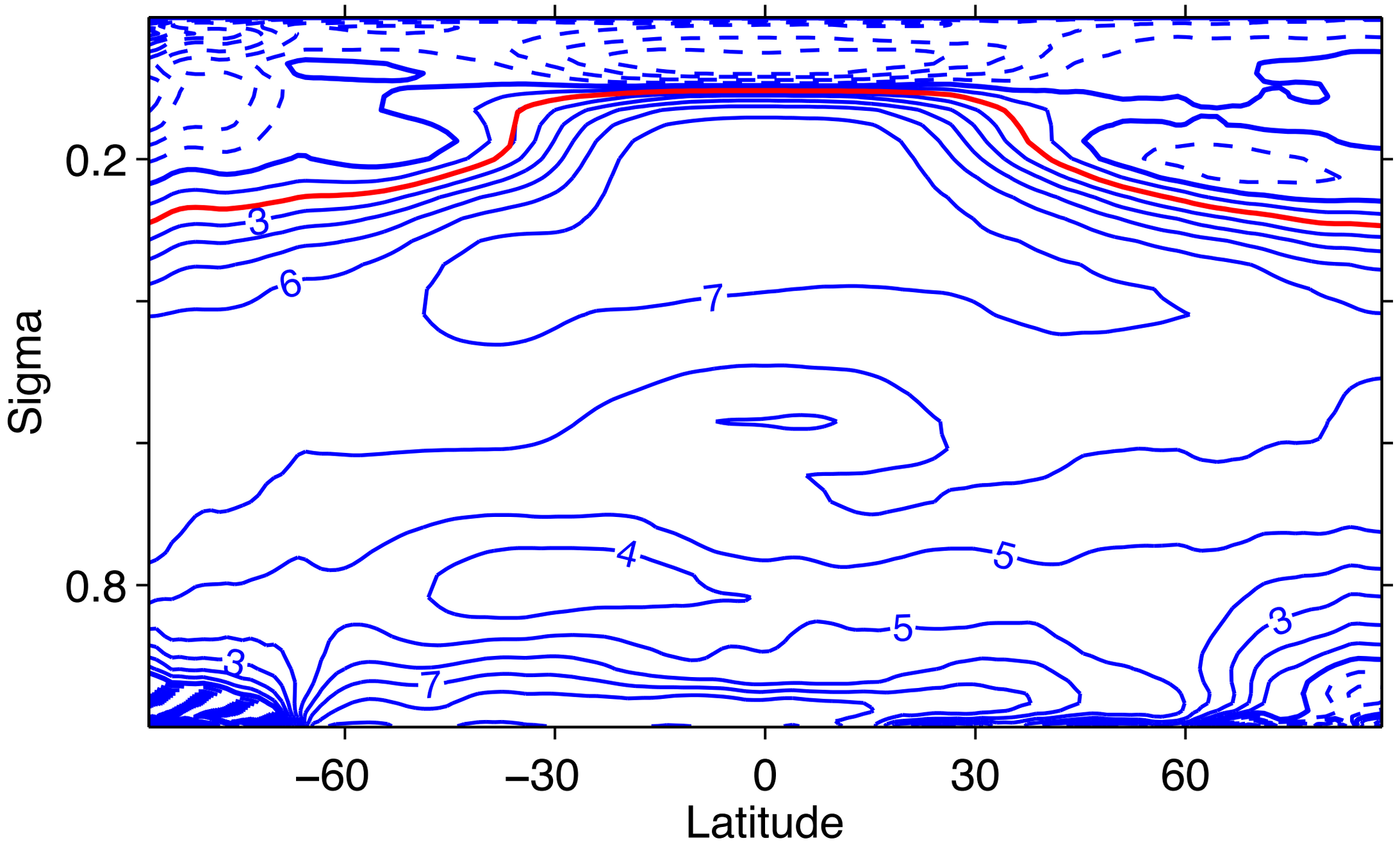
ERA40 reanalysis data 1980-2001

Potential temperature (K)



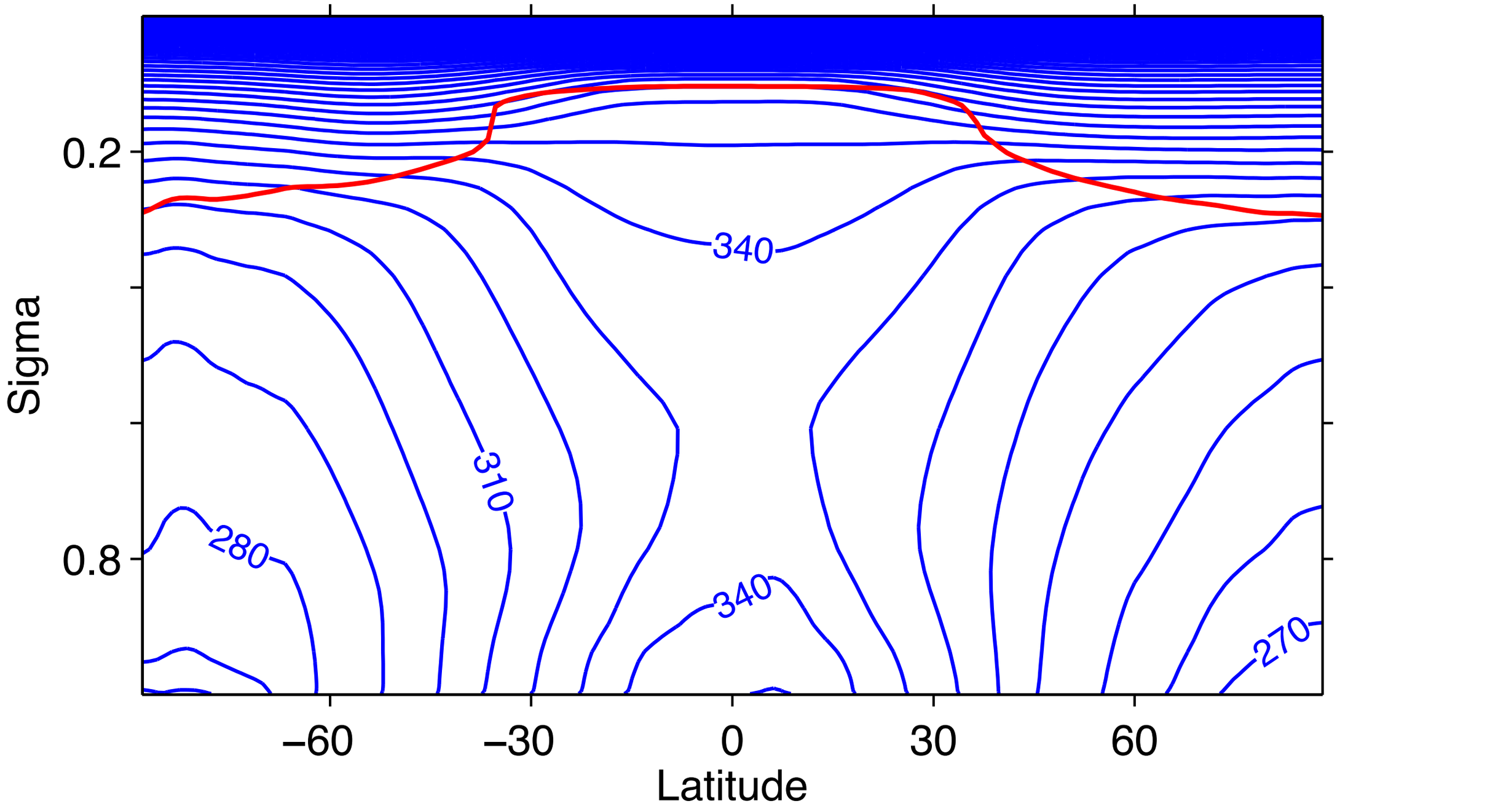
ERA40 reanalysis data 1980-2001

Temperature lapse rate (K/km)



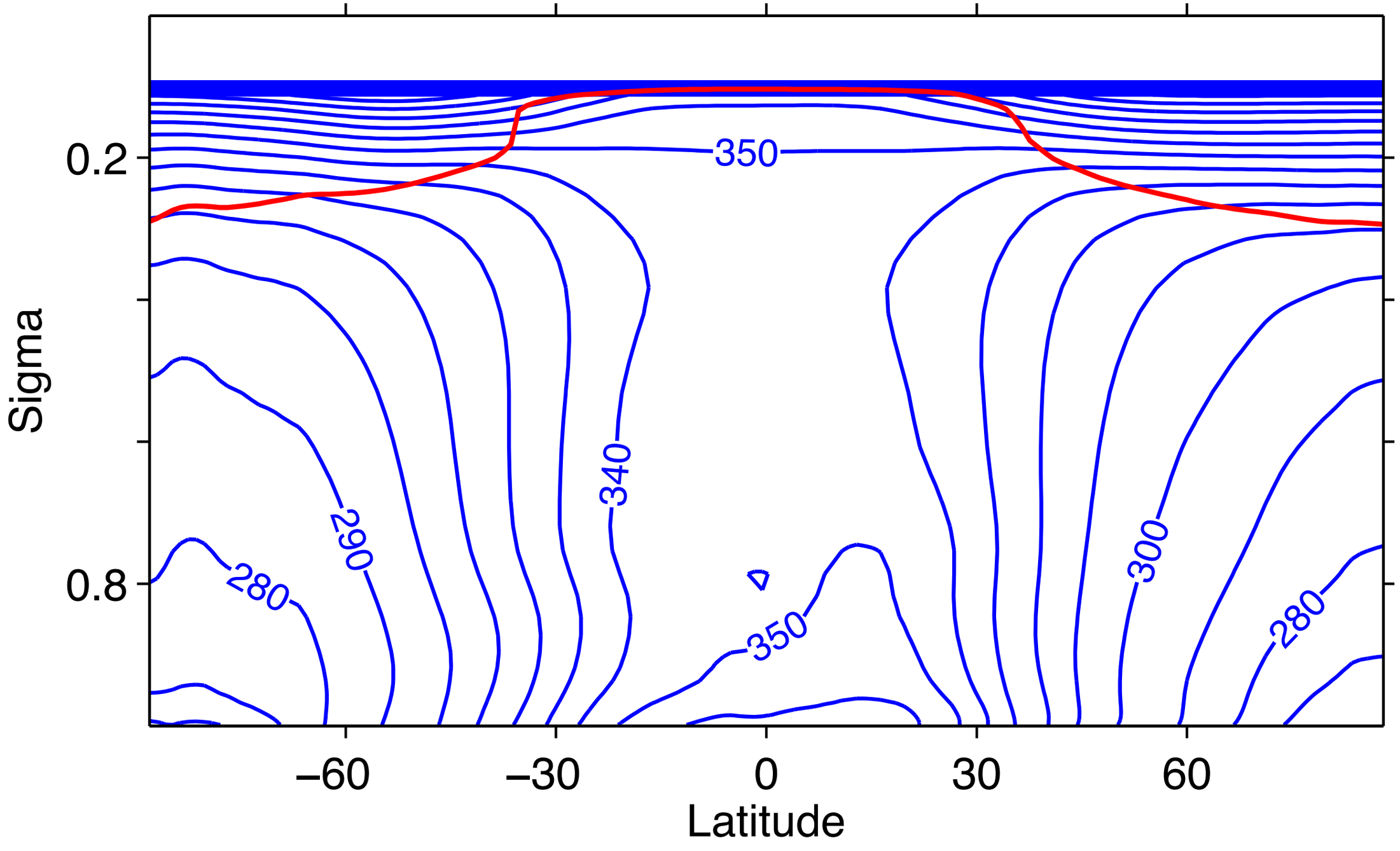
ERA40 reanalysis data 1980-2001

Equivalent potential temperature (K)



(ERA40 reanalysis data 1980-2001)

Saturation equivalent potential temperature (K)



ERA40 reanalysis data 1980-2001

Extratropical mean state is stable to slantwise moist convection except in summer in Northern midlatitudes

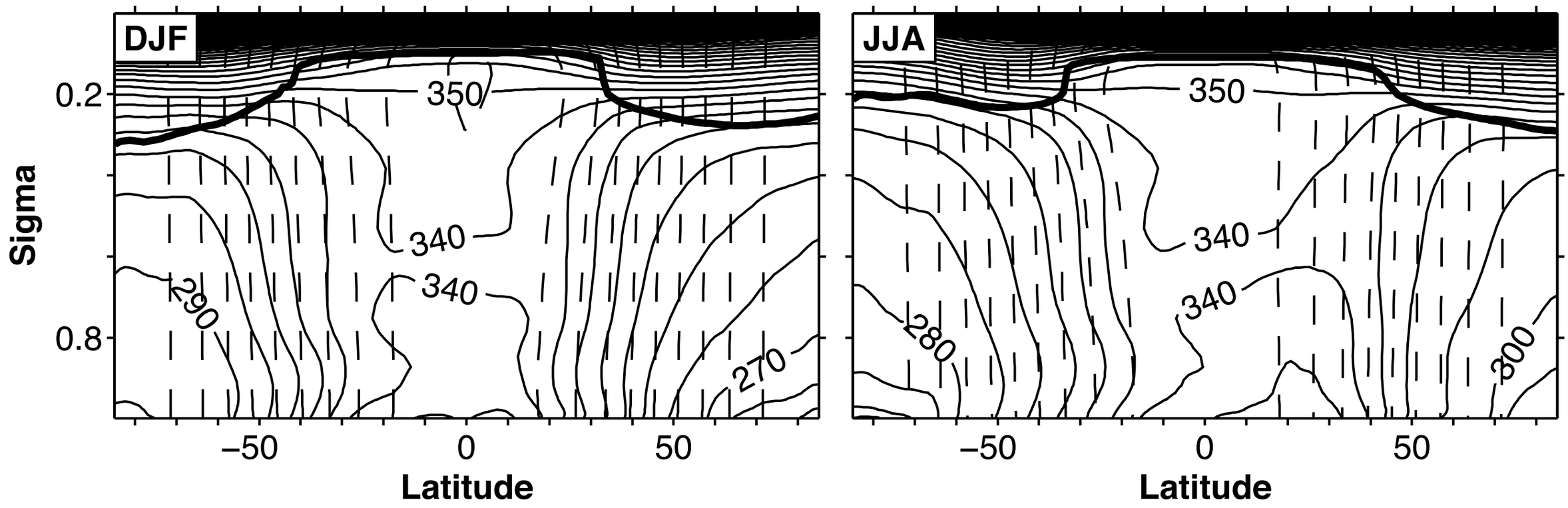
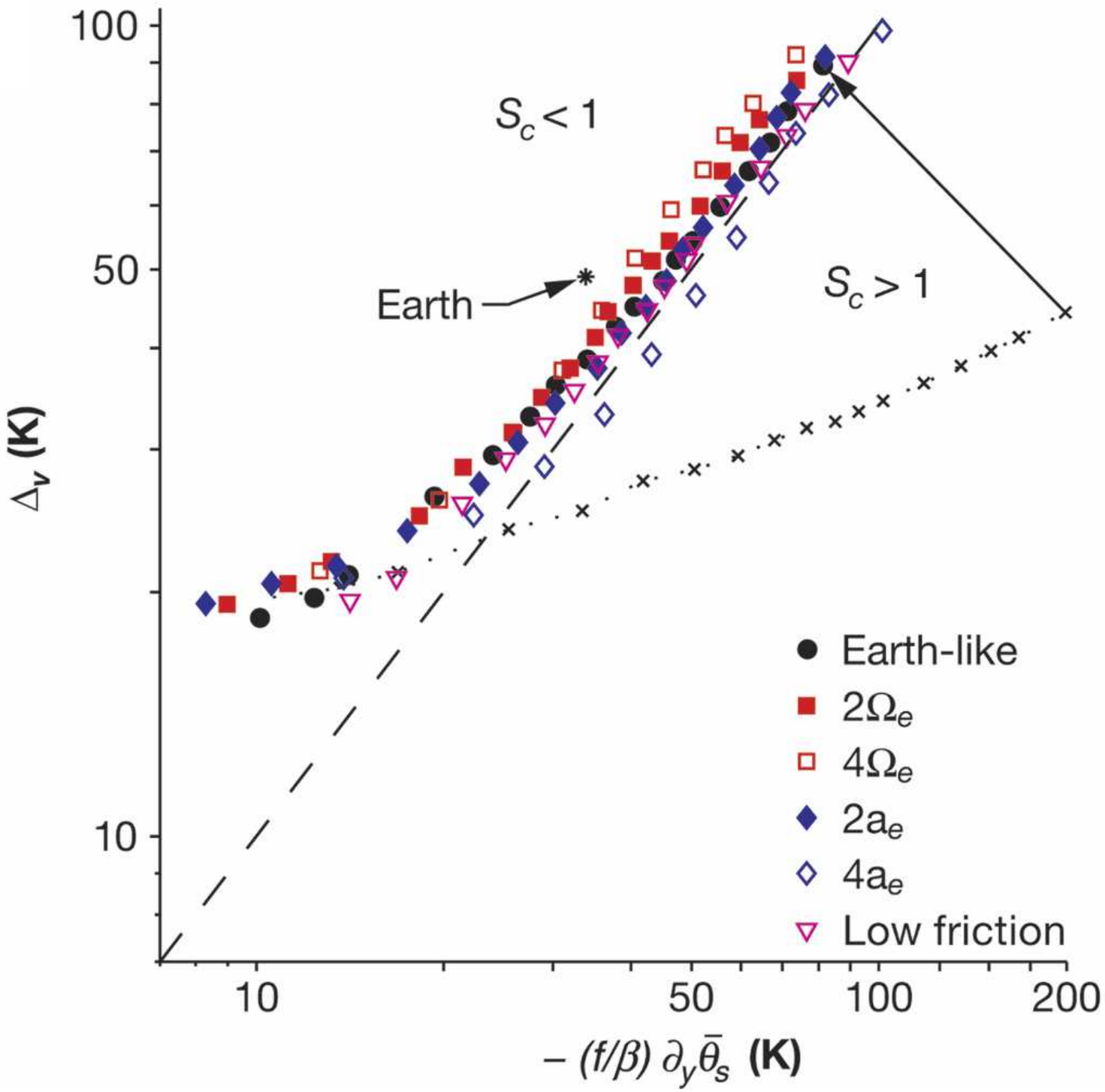


Figure 9.5 Saturated moist pseudoadiabats (solid) and surfaces of constant absolute angular momentum M (dashed) according to ERA-40 reanalysis data for 1980–2001. The contour interval for angular momentum is $0.1\Omega a^2$, and contour values decrease monotonically from the equator to the poles. The thick line marks the tropopause.

Schneider, Thermal Stratification of the extratropical troposphere, 2006

Adjustment to thermal state with supercriticality Sc~1 in extratropics of dry atmospheres



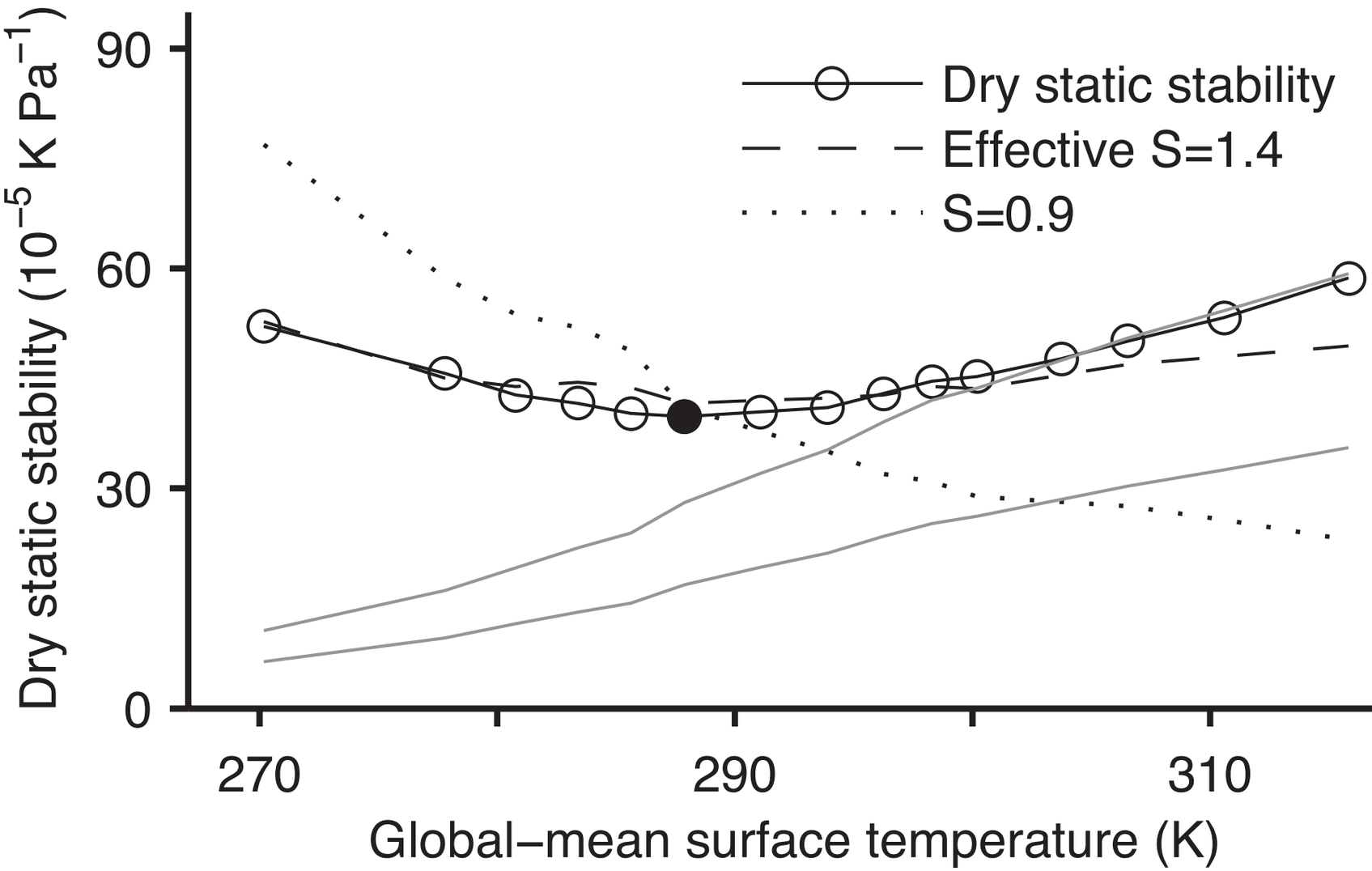
Simulations are performed for a range of different:

- meridional temperature gradients in radiative equilibrium
- planetary radii or rotation rates

Crosses show values in radiative equilibrium

Schneider and Walker, JAS, 2006

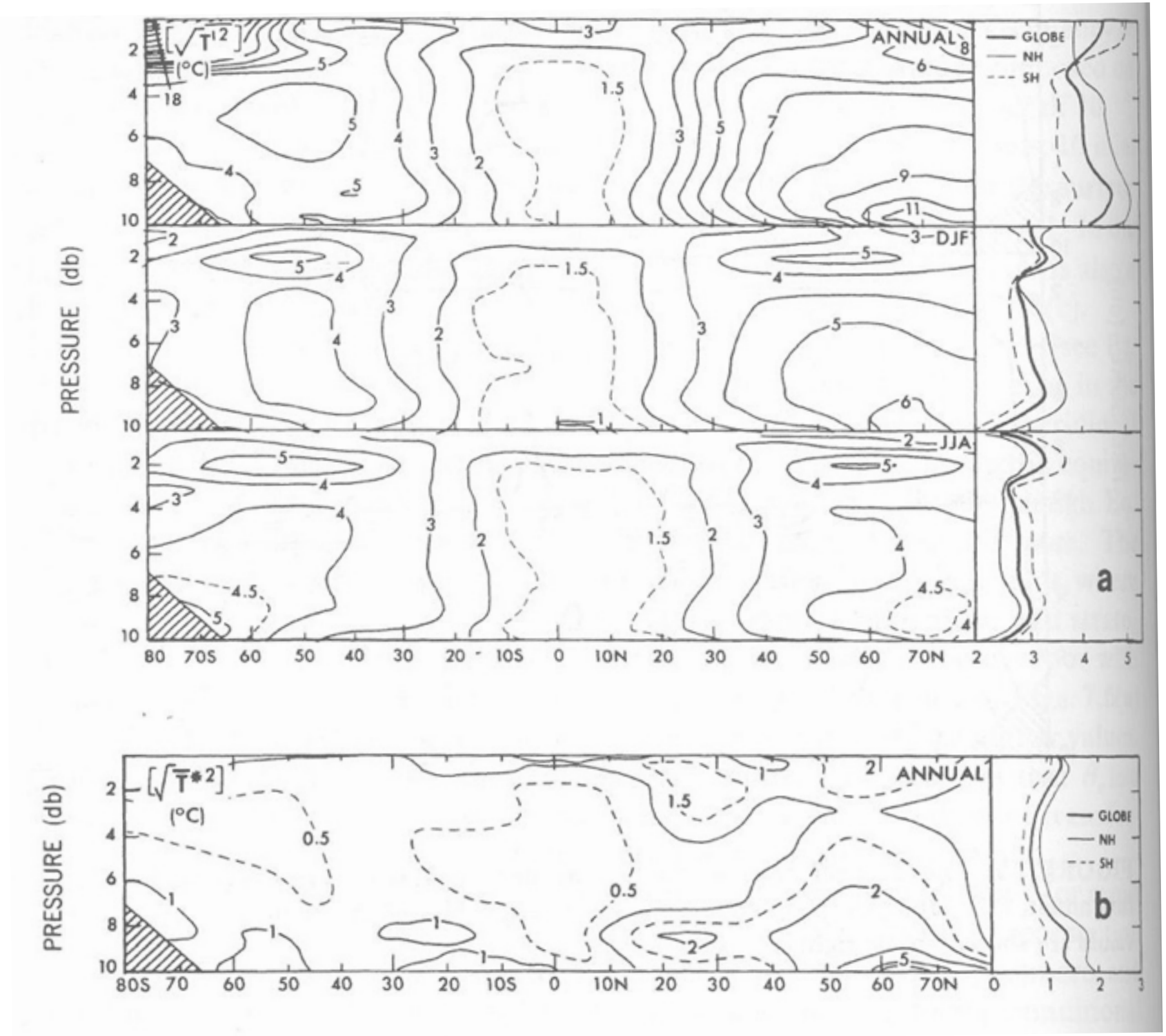
Supercriticality decreases in warm and moist climates, but stays constant if use effective static stability to represent latent heating



Simulations in moist idealized GCM over a wide range of climates
Lower gray line is contribution from latent heating
Upper gray line corresponds to moist adiabatic stratification

O'Gorman, JAS, 2011

Standard deviation of temperature (K)



Transient

Transient DJF

Transient JJA

Stationary

Peixoto and Oort, fig 7.8