ANGULAR MOMENTUM AND THE CORIOLIS EFFECT

As air moves poleward from the equator it gets closer to the earth's axis of rotation. As air moves toward the equator the earth's axis of rotation is more distant. Moving poleward requires air to accelerate to conserve angular momentum. Therefore, its angular velocity must increase.

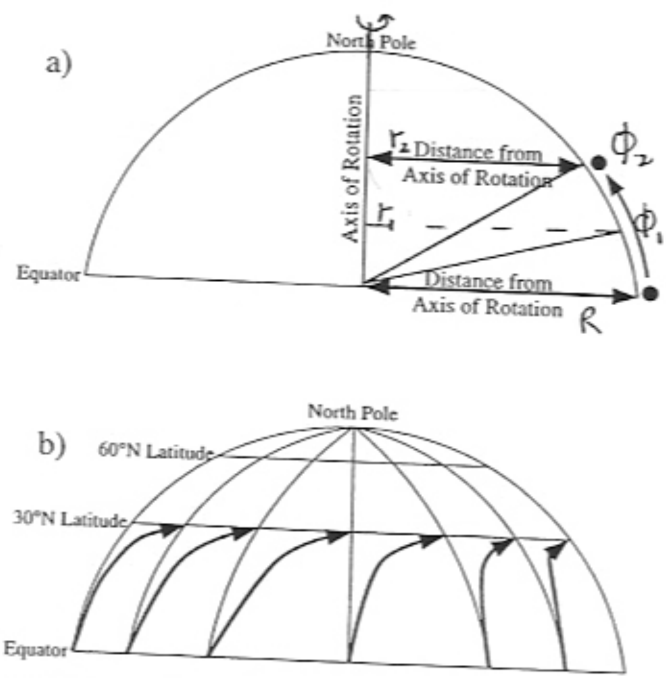

Figure 7.12. (a) As a parcel of air moves poleward from the equator, it gets closer to the earth's axis of rotation. Like an ice skater pulling her arms in toward her body during a spin, the parcel accelerates eastward as it tries to conserve its angular momentum; (b) As air flows northward from equatorial regions, it is deflected to the east by the Coriolis force. At the same time, it gains speed as it conserves its angular momentum. These two effects work in tandem to create the subtropical jet stream near 30° latitude.

Initially, the radius of rotation is

$$r_1 = R\cos\phi_1$$

Angular momentum (per unit mass) is

$$\omega_1 r_1^2 = \Omega r_1^2 = \Omega(R\cos\phi_1)^2$$

At latitude ϕ_2,

$$\omega_2 r_2^2 = \omega_2(R\cos\phi_2)^2$$

Since this must equal the original value,

$$\omega_2(R\cos\phi_2)^2 = \Omega(R\cos\phi_1)^2$$

$$\omega_2 = \Omega\left[\frac{\cos\phi_1}{\cos\phi_2}\right]^2$$

and

$$\omega_2 > \Omega$$

Therefore, air rotates around the axis of the earth more quickly than does the earth itself.