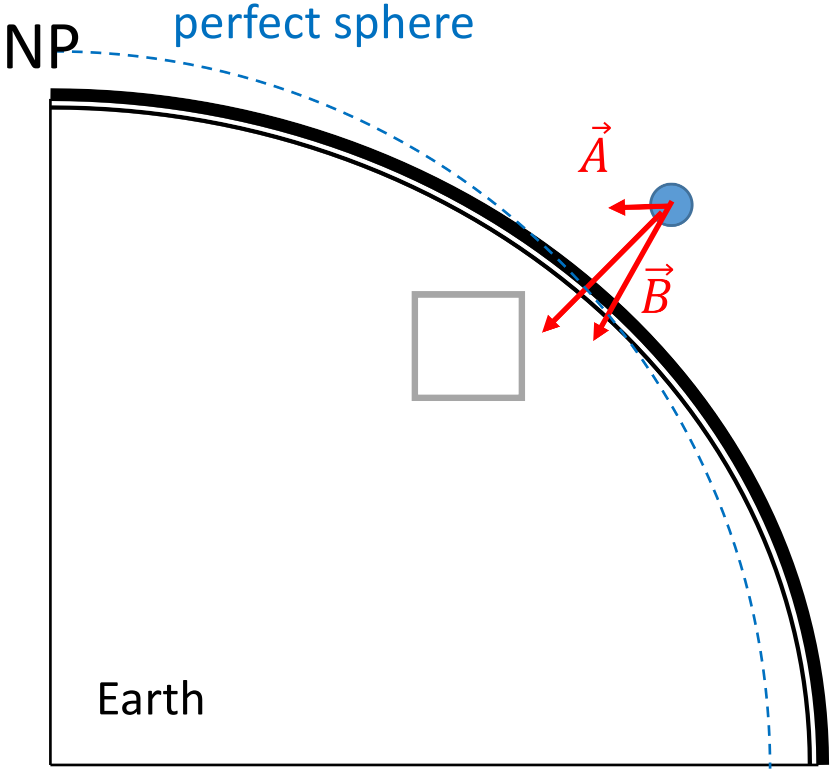
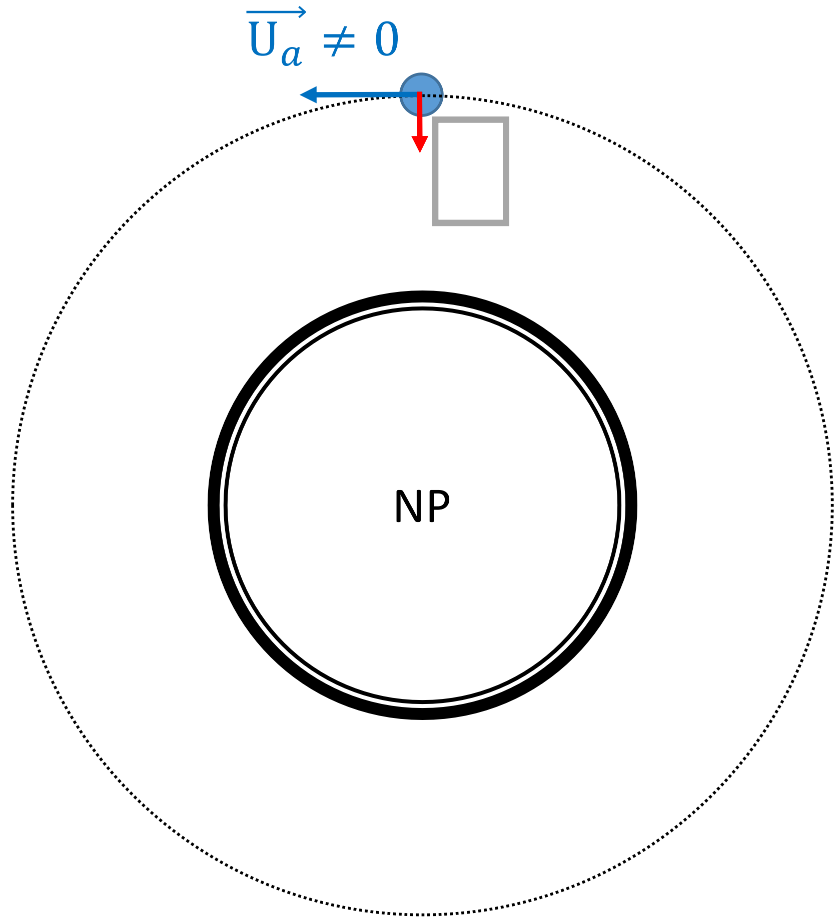
Consider a ‘motionless’ atmosphere to an observer at Earth’s surface
(i.e. the observer is rotating around the Earth’s axis of rotation)

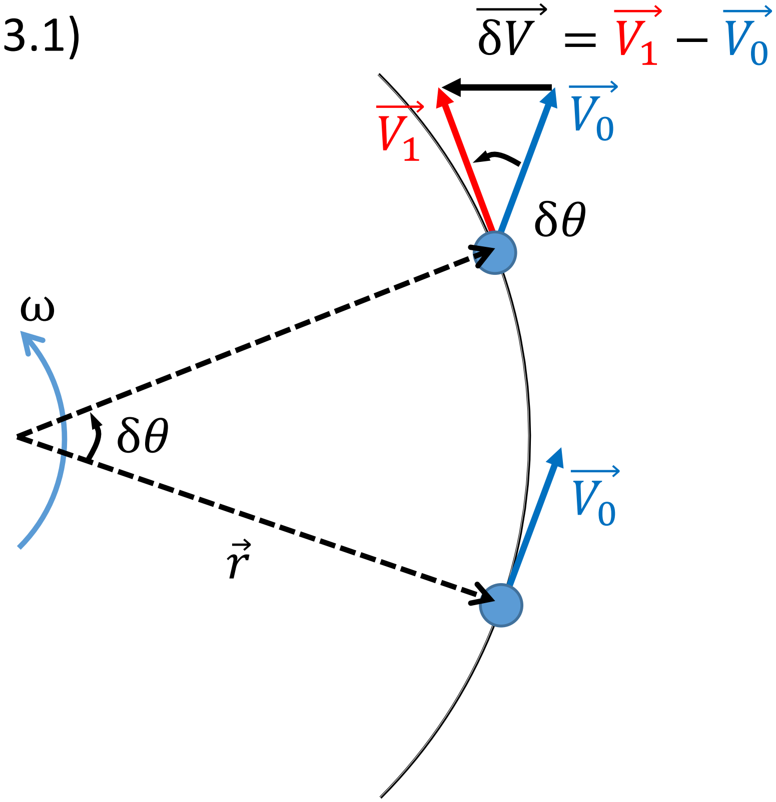
- In a **fixed** frame of reference : air parcels are moving
- What causes the movement?





$$\frac{D_a \overrightarrow{U_a}}{Dt} = -\frac{1}{\rho}\nabla \cdot p - \overrightarrow{g^*} + \overrightarrow{F_r}$$

Centripetal acceleration
(Ch. 1.3.1)



Speed of the parcel

$|\vec{V}| = \square$

Angular velocity

$\frac{D\theta}{Dt} = \square$

Acceleration vector $\frac{D\vec{V}}{Dt} = \lim_{\delta t \to 0} \frac{\delta \vec{V}}{\delta t}$

Magnitude

$|\delta\vec{V}| = \square$

$\left|\frac{\delta\vec{V}}{\delta t}\right| = \square$

$\delta t \to 0$

$\left|\frac{D\vec{V}}{Dt}\right| = \square$

Direction

$\square$

Acceleration vector $\frac{D\vec{V}}{Dt} = \square$

$= \square$

$= \square$

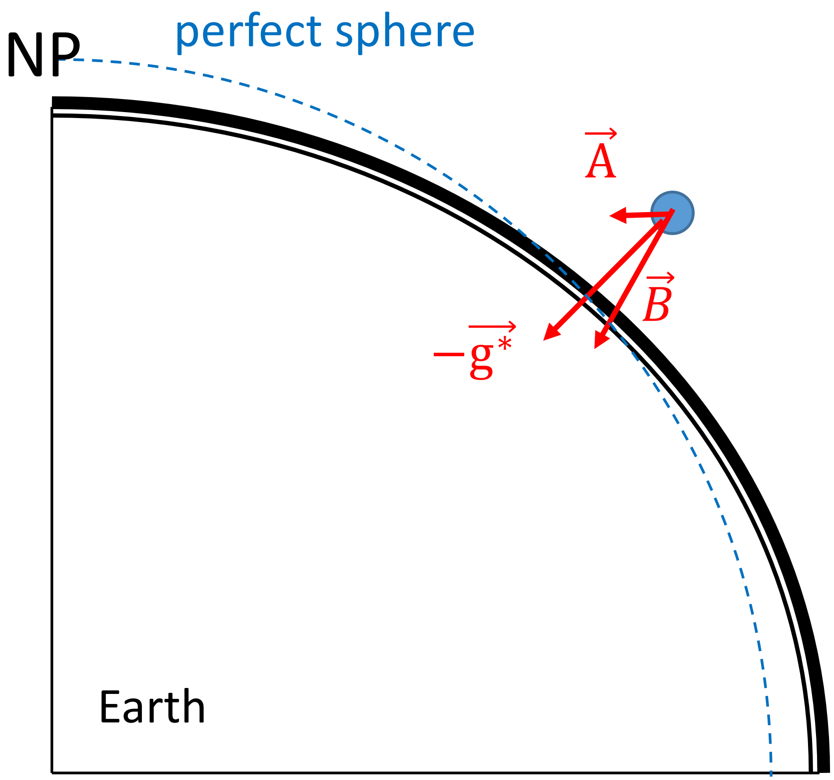
In case of the Earth $\frac{D\vec{V}}{Dt} = \square$

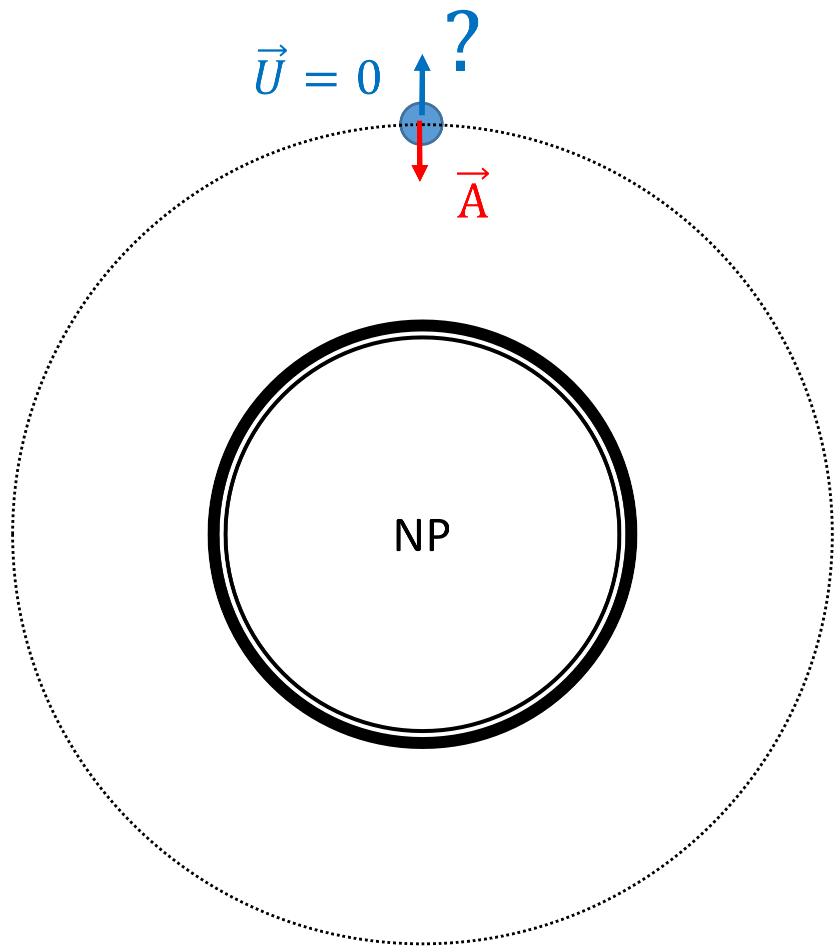
Ω: the angular speed of rotation of Earth

$\vec{R}$: the position vector from the axis of rotation to the object

Consider a ‘motionless’ atmosphere to an observer at Earth’s surface
(i.e. the observer is rotating around the Earth’s axis of rotation)

- In a **rotating** frame of reference : air parcels are **NOT** moving
- What balances the real force?

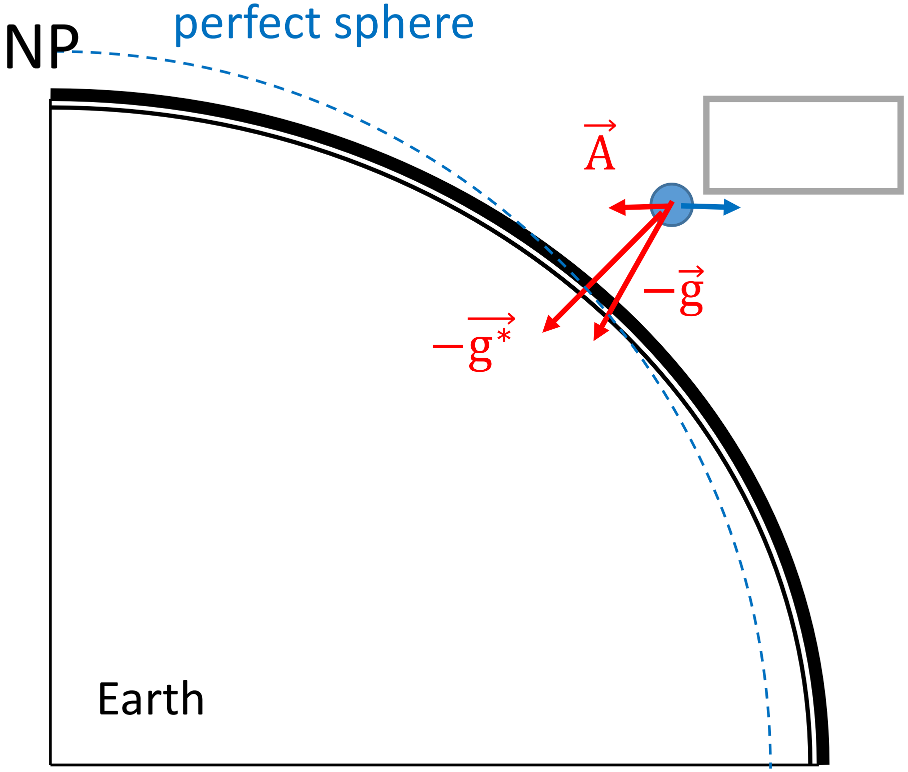


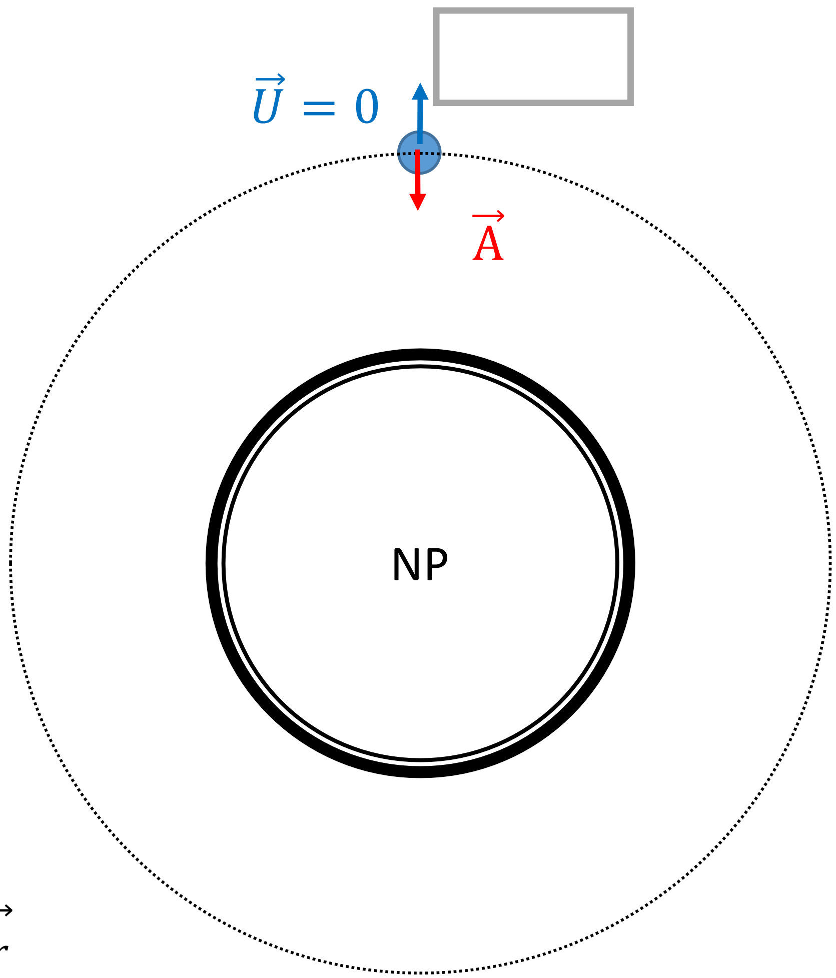


$$\frac{D\vec{U}}{Dt} = -\frac{1}{\rho}\nabla \cdot p - \vec{g^*} + \Omega^2\vec{R} - 2\,\vec{\Omega} \times \vec{U} + \vec{F_r}$$

Consider a ‘motionless’ atmosphere to an observer at Earth’s surface
(i.e. the observer is rotating around the Earth’s axis of rotation)

- Sum of the true gravitational force and centrifugal force: (apparent) gravitational force
- Apparent gravitational force vector: perpendicular to surface

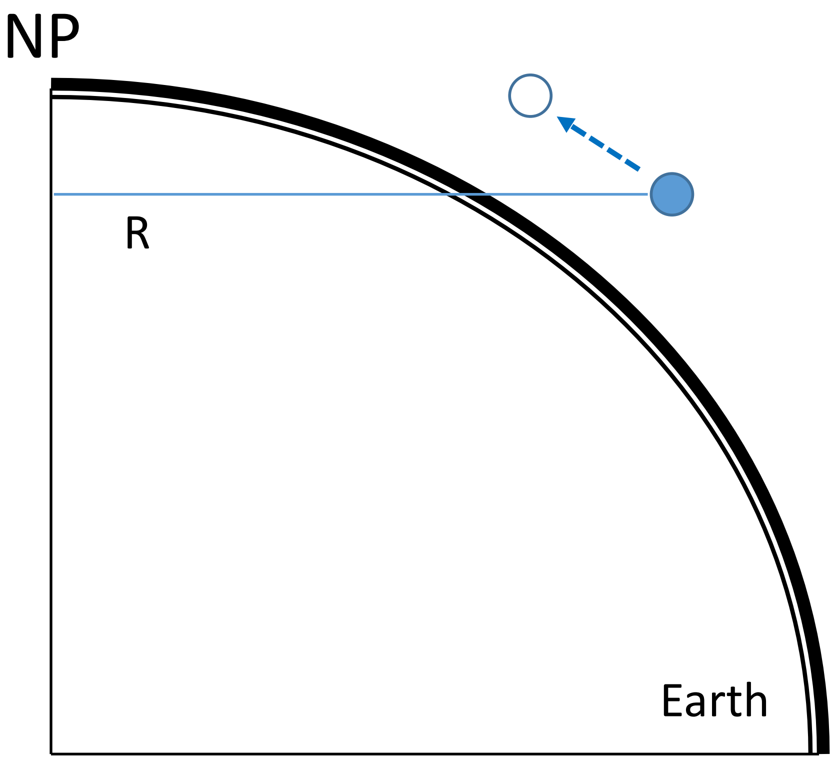




$$\frac{D\vec{U}}{Dt} = -\frac{1}{\rho}\nabla \cdot p - \vec{g^*} + \Omega^2\vec{R} - 2\,\vec{\Omega} \times \vec{U} + \vec{F_r}$$

From the conservation of angular momentum..

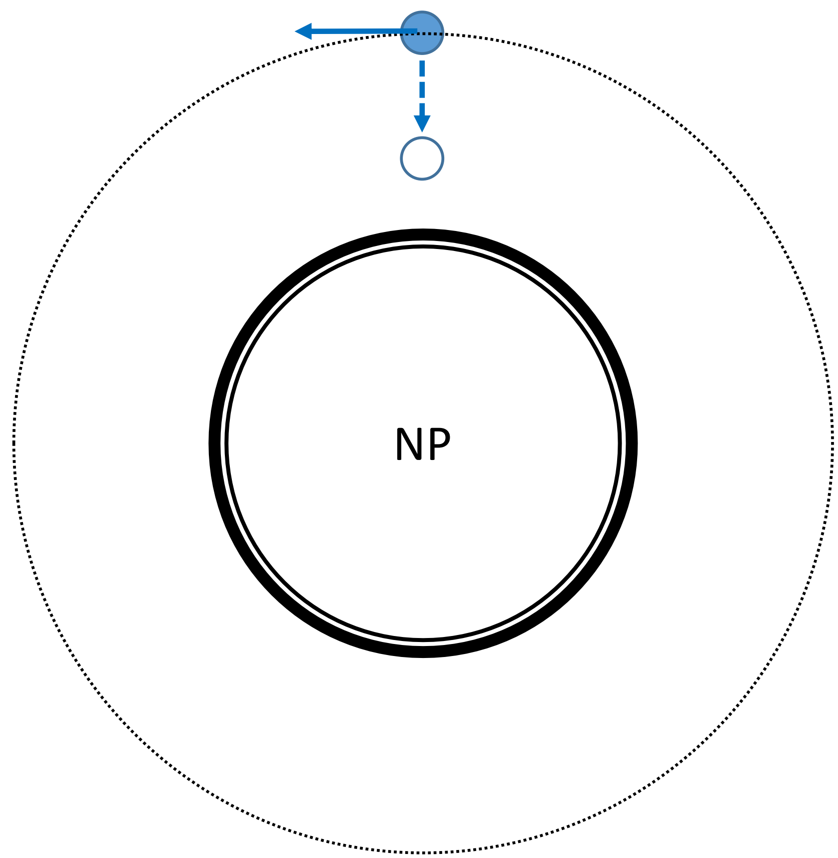
- North-south or upward-downward movement of an air parcel would affect zonal momentum



Angular momentum of an air parcel

$m = \Omega R^2 + uR$

$\vec{U} = (u, 0,0) \neq 0$



From angular momentum conservation

$$\frac{Dm}{Dt} = \boxed{}$$

Rearrange

$$\frac{Du}{Dt} = \boxed{}$$

Using the definition of R $R = r\cos\emptyset$

$$\frac{DR}{Dt} = \boxed{} = \boxed{}$$

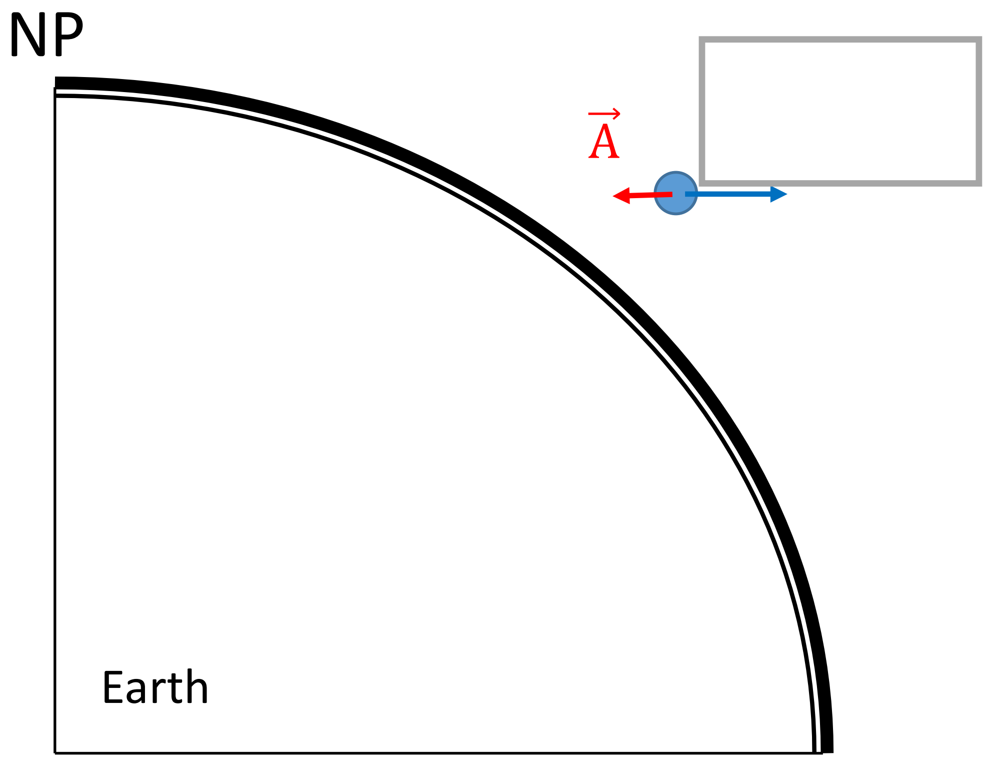
Upon substitution

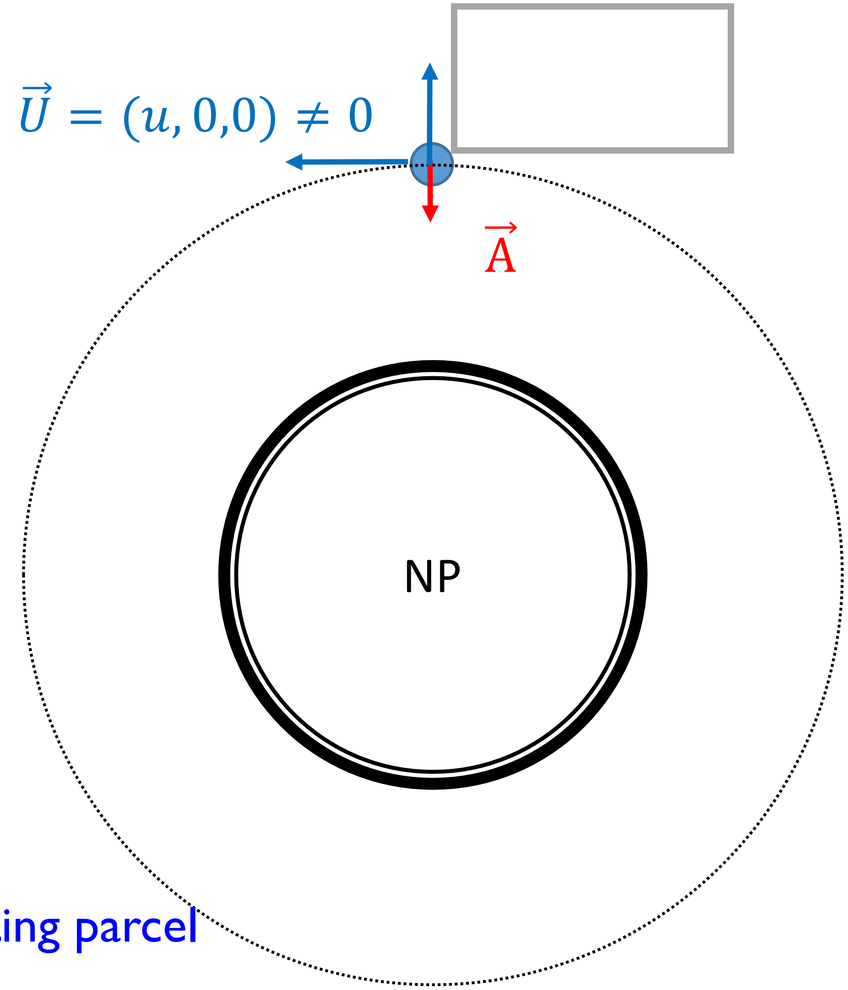
$$\frac{Du}{Dt} = \boxed{}$$

$$= \boxed{}$$

The air parcel is set in motion in the eastward direction by an impulsive force

- Angular momentum is not conserved
- The centrifugal force will increase





Excess of the centrifugal force over that for a resting parcel

$$-\,\Omega^2\vec{R} =$$

Excess of the centrifugal force over that for a resting parcel

Meridional and vertical components of $\frac{\vec{\mathrm{R}}}{R}$

$$\frac{\vec{\mathrm{R}}}{R} = (0, \quad , \quad)$$

Upon substitution

$$\frac{Dv}{Dt} =$$

$$\frac{Dw}{Dt} =$$

Combining results & neglecting the metric terms

$$\frac{Du}{Dt} =$$

$$\frac{Dv}{Dt} =$$