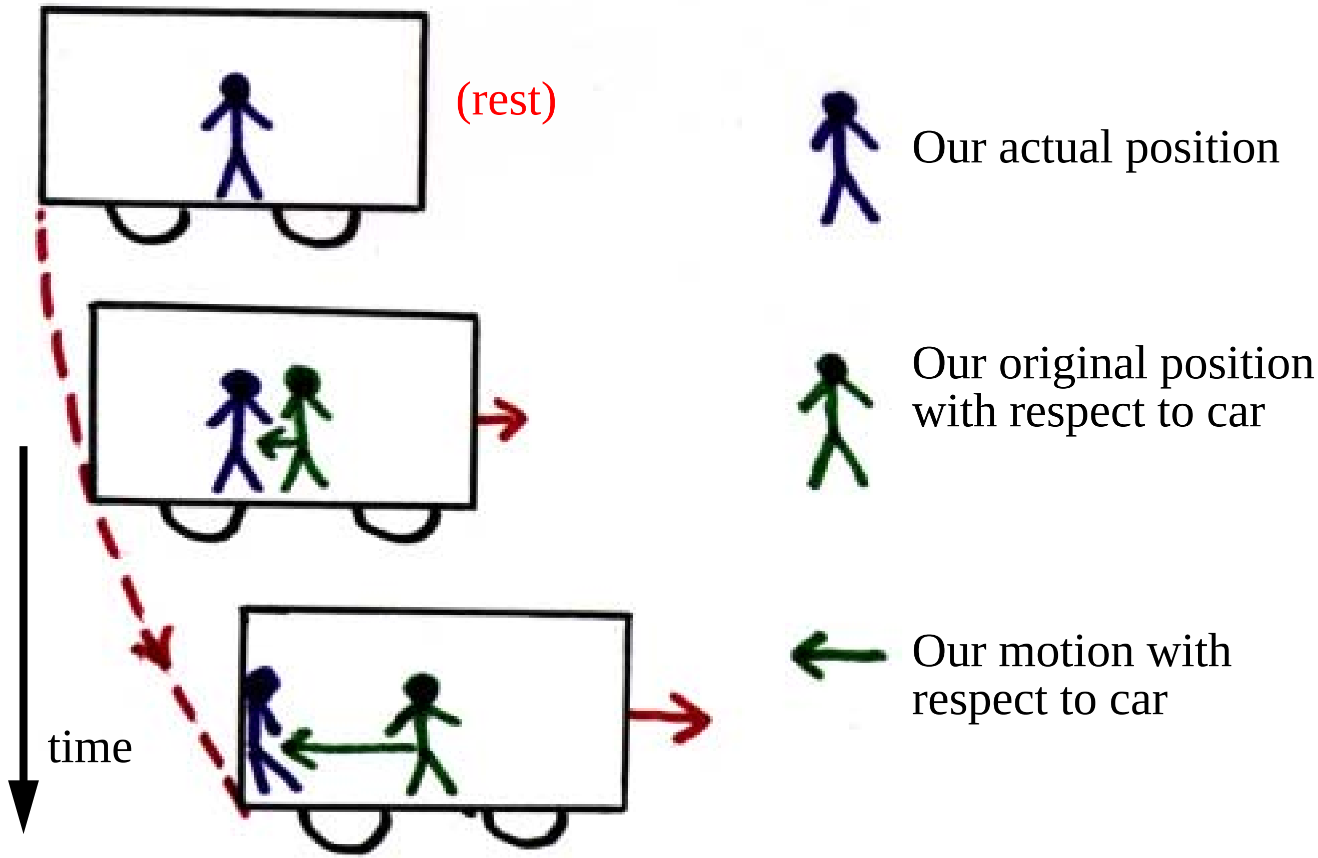
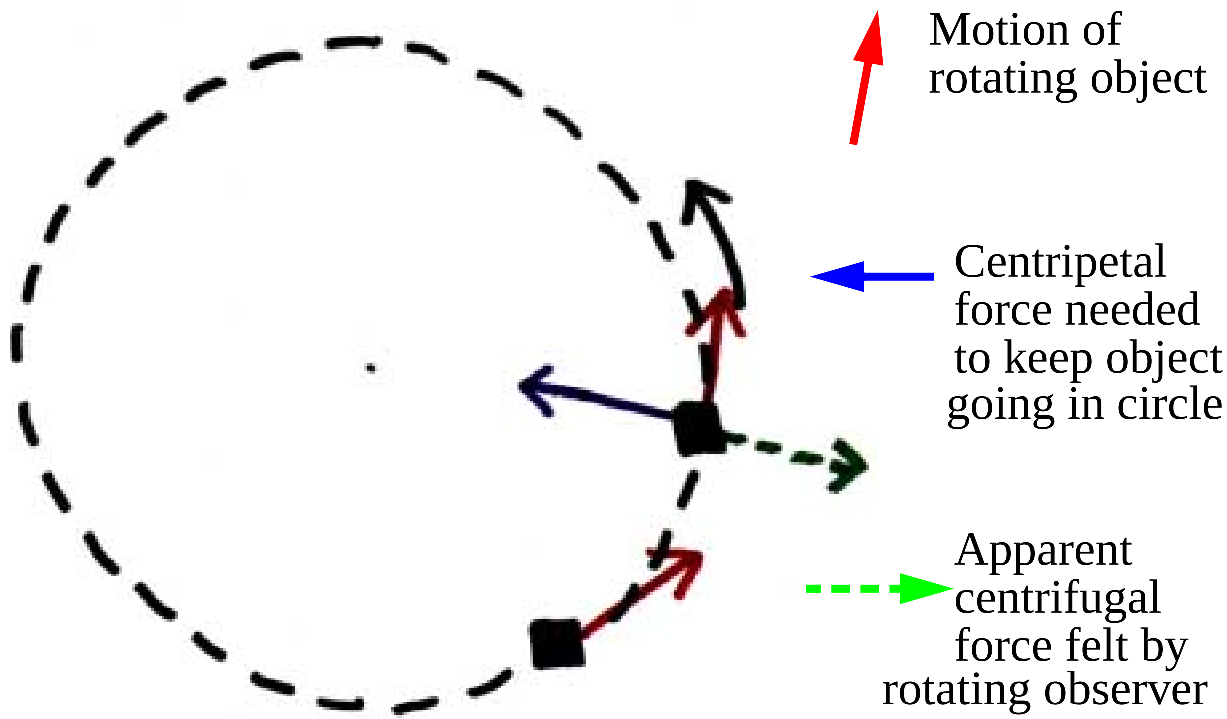
Lecture 9 The Coriolis Force

Life in an Accelerating Reference Frame

- Suppose we step into a subway car with a Teflon floor.
- When the train starts to accelerate, we slide backward until we hit the back wall.
- From our perspective in the accelerating car, there is a backward ‘apparent’ force that rammed us into the back wall.



On the rotating earth, we feel similar ‘apparent’ forces because it takes a force to accelerate an object in a circle.



These apparent forces are:

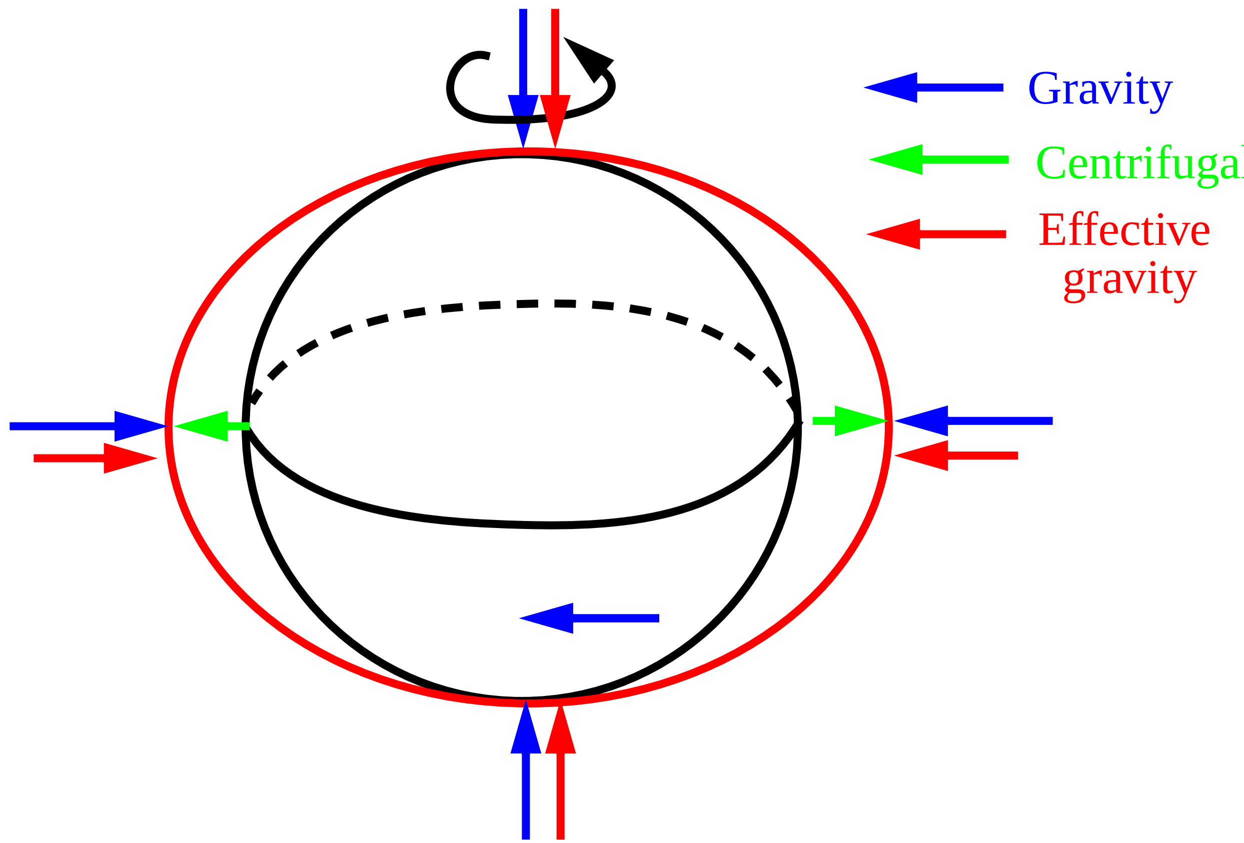
Centrifugal force

Coriolis force

Centrifugal 'Force'

- Apparent force pulling outward from Earth's polar axis.
- Slightly changes the apparent gravity

  0.5% weaker at the equator than at poles



- Sea level (and Earth surface) are pulled 20 km (0.3%) further from the center of the earth at the equator than at poles.
- By redefining 'gravity' to point perpendicular to sea level everywhere we can absorb centrifugal 'force' into gravity.

Coriolis ‘force’ or effect

- An apparent force on *moving* objects on the rotating Earth. (Gaspard Coriolis, 1848)

EOM 6.12

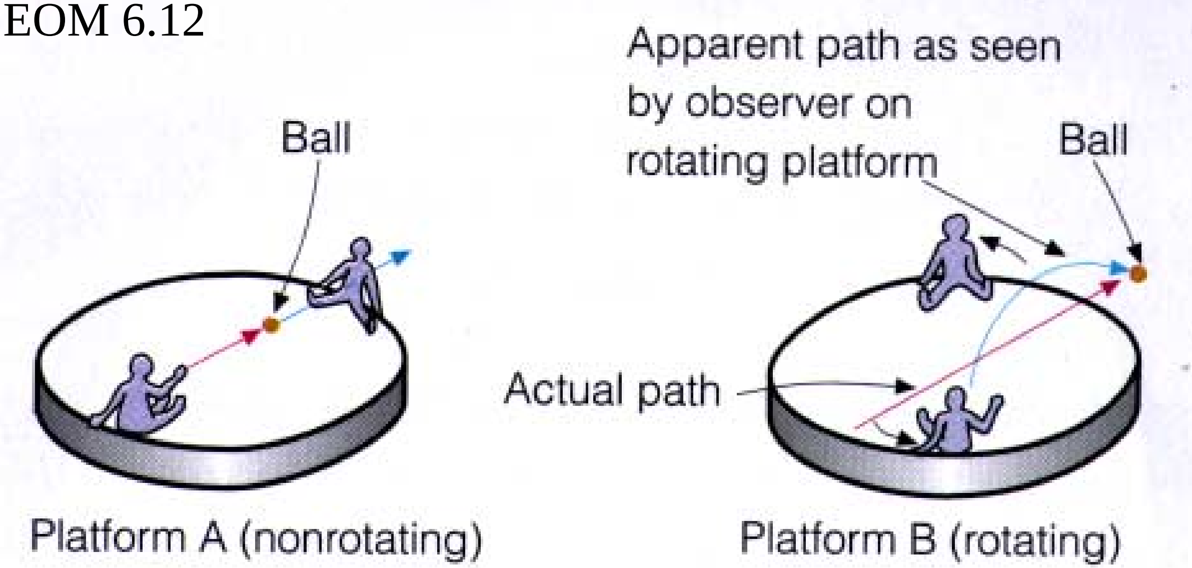


FIGURE 6.12

On nonrotating platform A, the thrown ball moves in a straight line. On platform B, which rotates counterclockwise, the ball continues to move in a straight line. However, platform B is rotating while the ball is in flight; thus, to anyone o platform B, the ball appears to deflect to the right of its intended path.

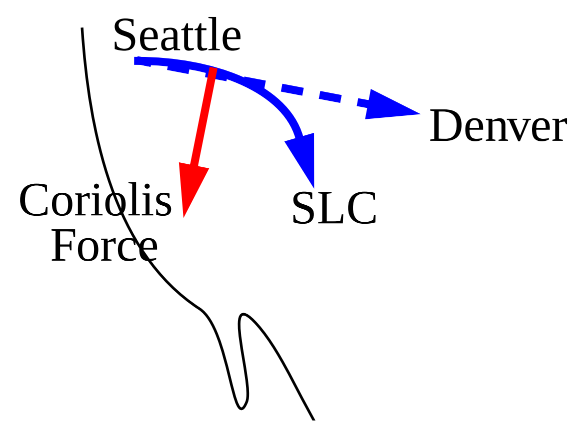
Coriolis force increases proportional to ...

- Rotation rate of the planet
- Latitude.
- Speed of the object

It accelerates moving objects to their right in the Northern Hemisphere and to their left in the Southern Hemisphere. There is no Coriolis force at the equator.

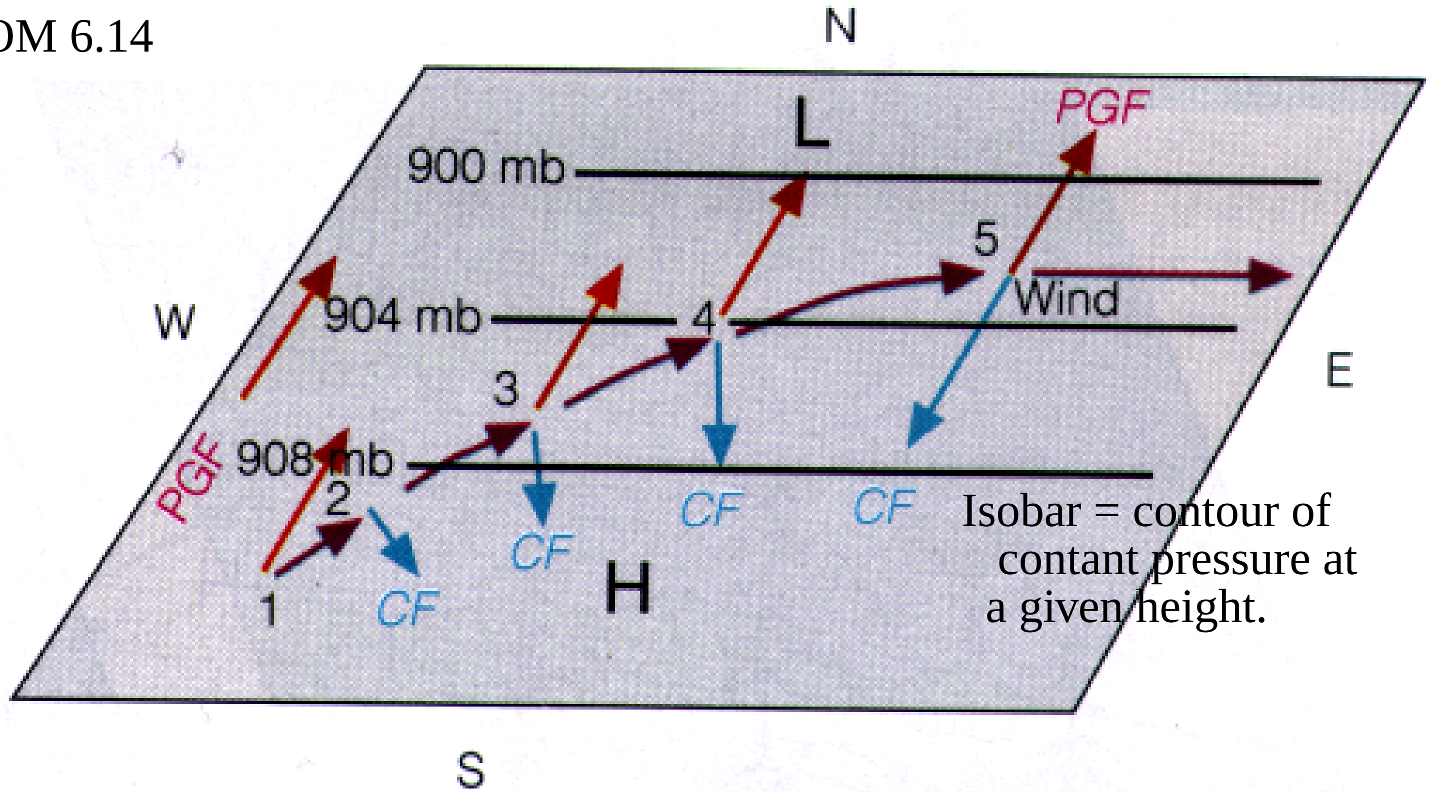
It is at right angles to the motion, changing a moving object's direction but not its speed.

A commercial jet flying from Seattle to Denver feels a sideways Coriolis force of 0.1% of gravity. If the jet starts flying toward Denver, it must imperceptibly tip its wings to compensate, else it would be deflected to Salt Lake City!



Coriolis Force and Air Motion

EOM 6.14



Isobar = contour of contant pressure at a given height.

FIGURE 6.14

Above the level of friction, air initially at rest will accelerate until it flows parallel to the isobars at a steady speed with the pressure gradient force (PGF) balanced by the Coriolis force (CF). Wind blowing under these conditions is called geostrophic.

Closely packed contours ⇒ Strong PGF ⇒ Strong wind

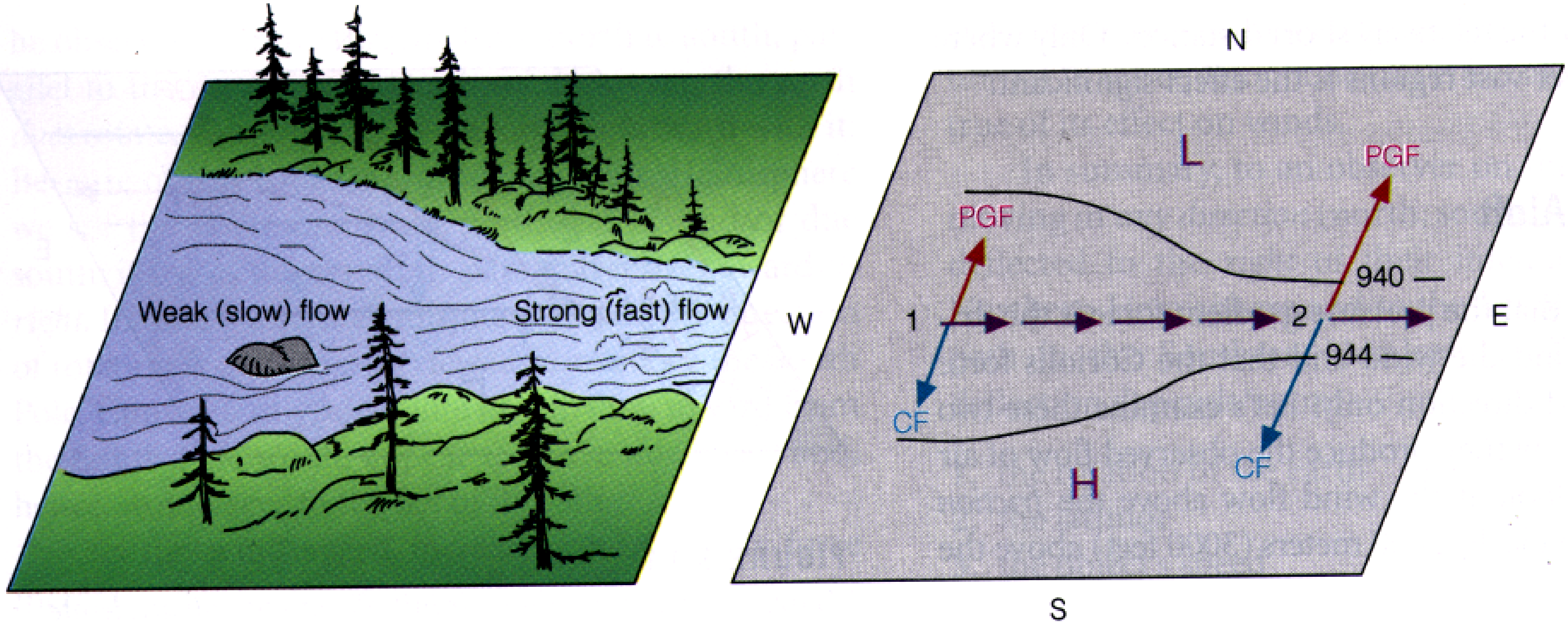
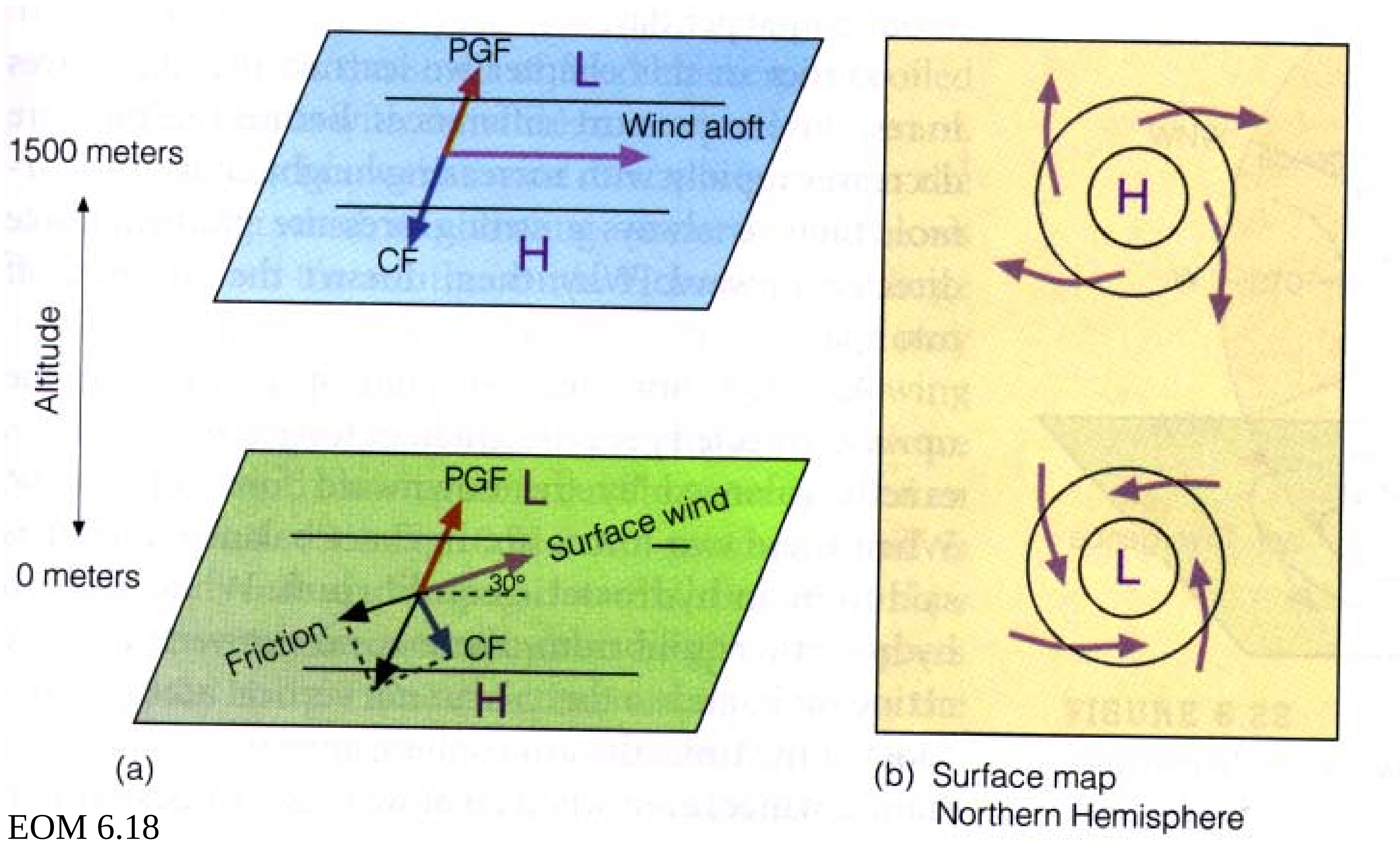


FIGURE 6.15 (EOM)

The isobars and contours on an upper-level chart are like the banks along a flowing stream. When they are widely spaced, the flow is weak; when they are narrowly spaced, the flow is stronger. The increase in winds on the chart results in a stronger Coriolis force (CF), which balances a larger pressure gradient force (PGF).

Except near surface, winds are nearly **geostrophic**, blowing along the isobars at a speed for which the Coriolis force (CF) nearly balances the PGF.

Effect of Friction



EOM 6.18

Friction causes near-surface wind to spiral out of high, in toward low pressure. Less friction over water than land, so surface wind blows more along isobars.