Wind Resource

B. Wind Motion

1. Macroscopic Motions

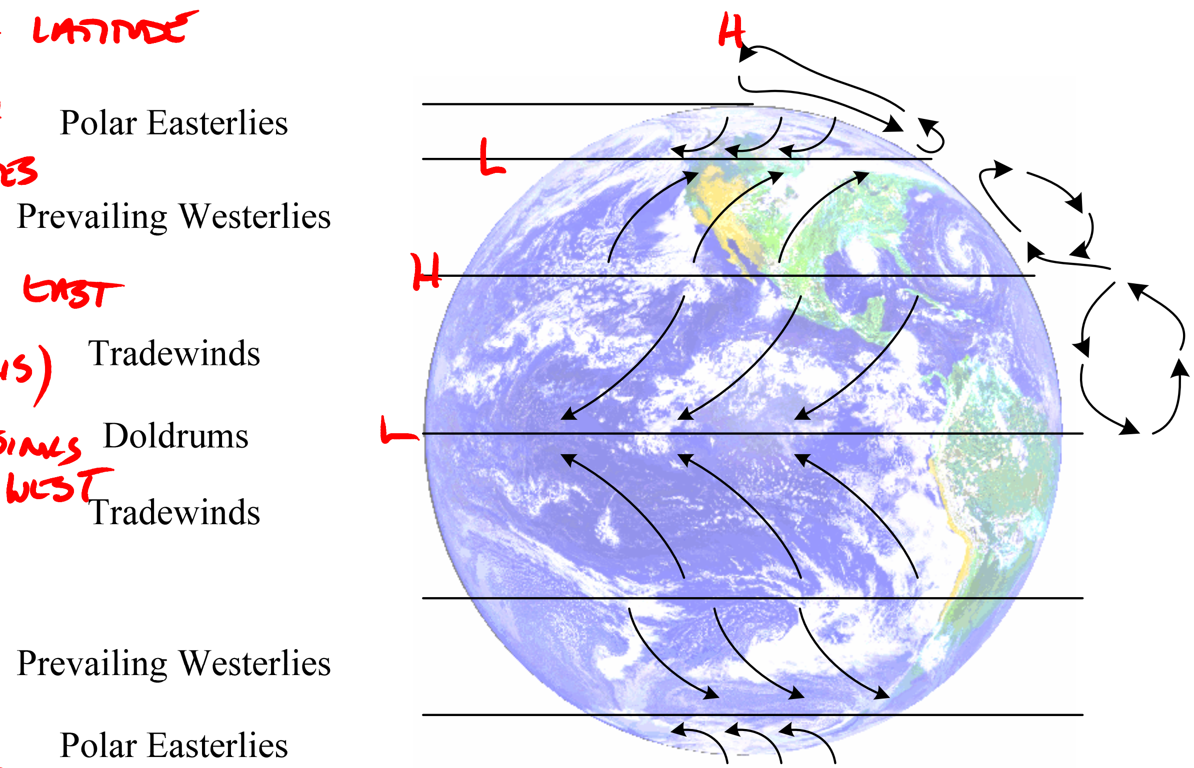
- AT 30° – 60° NORTH / SOUTH LATITUDE

  SINKING AIR FROM BOTH EQUATOR & HIGHER LATITUDES CAUSES HIGH PRESSURE

  - AIR FLOWS NORTH & EAST
  - WESTERLIES (CORIOLIS)

- AT POLES, COOL AIR SINKS
  - AIR FLOW SOUTH & WEST
  - POLAR EASTERLIES

- A 60° NORTH, MEETING OF POLAR EASTERLIES & WESTERLIES



Wind Resource

B. Wind Motion

2. Microscopic Motions

SEVERAL EXAMPLES

LAND / SEA BREEZES

VALLEY / MOUNTAIN BREEZES

FOEHN / SANTA ANA

THUNDERSTORMS

LAND SEA BREEZES

DAY TIME

WARM LAND & COOL OCEAN

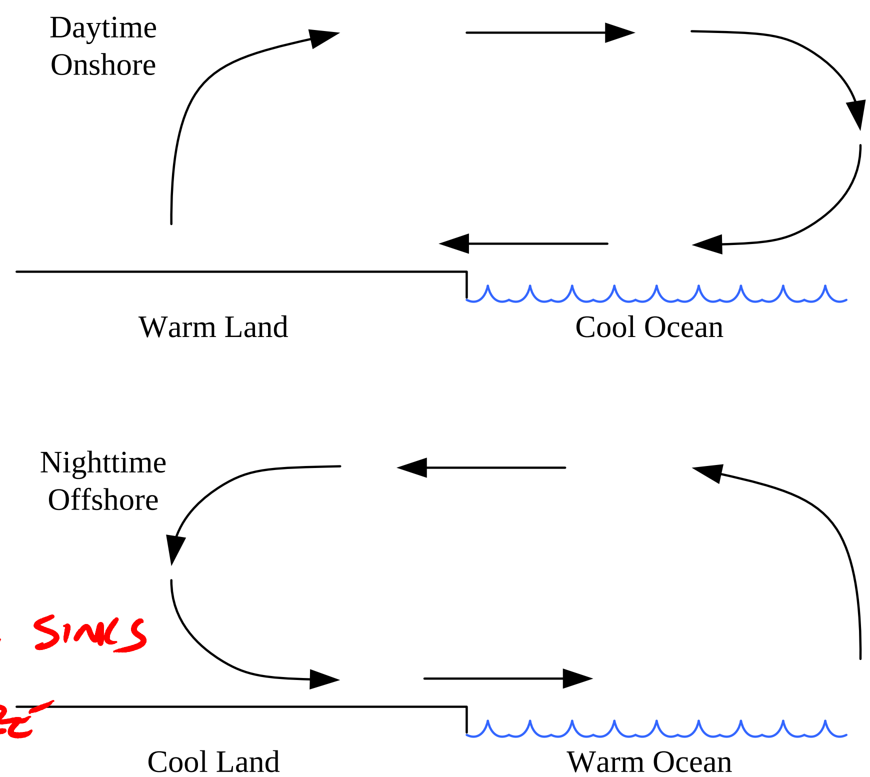
AIR RISES ON LAND, COOLS & SINKS

OVER OCEAN → ONSHORE BREEZE

NIGHT TIME

COOL LAND & WARM OCEAN

OFFSHORE BREEZE



Wind Resource

B. Wind Motion

2. Microscopic Motions

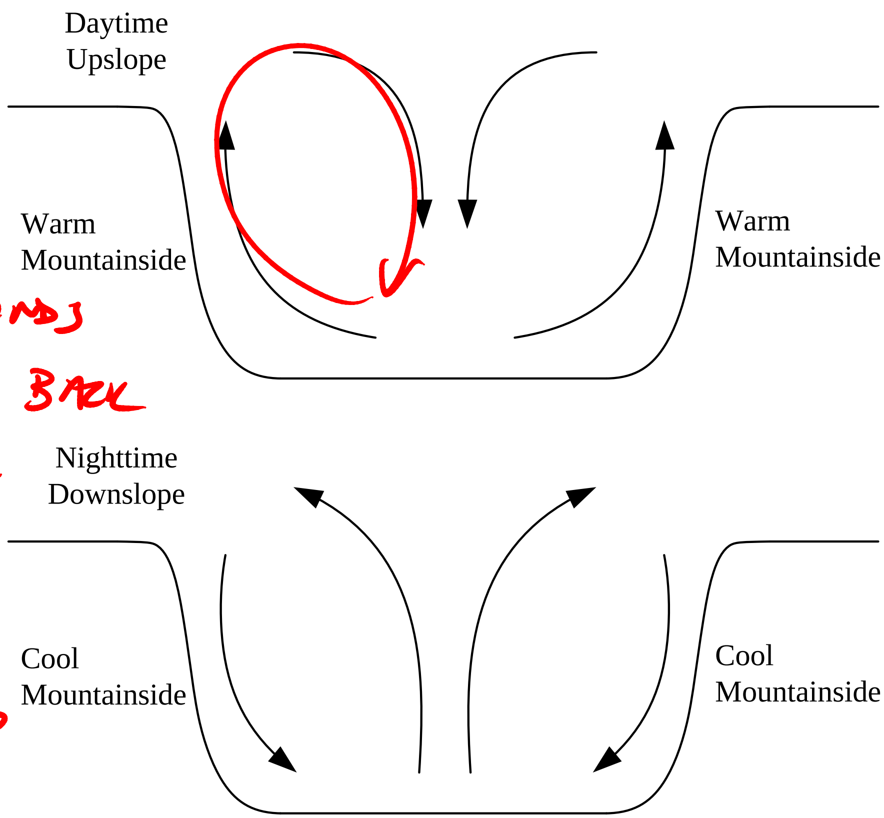
MOUNTAIN/VALLEY BREEZE

DAYTIME

VALLEY WALL WARMS

→ INDUCES UPSLOPE WINDS

→ AIR COOLS & FALLS BACK TO VALLEY FLOOR



3. INBETWEEN - MESOSCALE

LARGE WEATHER SYSTEMS

WINTER STORMS

HURRICANES & CYCLONES

Wind Resource

B. Wind Motion

3. Time Variation

WINDS VARY WITH TIME FOR MANY REASONS

TIME-SCALES ASSOCIATED WITH VARIATIONS ARE VERY DIFFERENT

SHORT-TERM VARIATIONS

TURBULENCE & OTHER UNSTEADINESS

CAUSES WIND VARIATIONS WITH TIME SCALES FROM SECONDS TO ~hour

DIURNAL VARIATIONS

VARIATIONS DUE TO HEATING OF ATMOSPHERE & LAND/SEA DURING DAY & COOLING AT NIGHT

Wind Resource

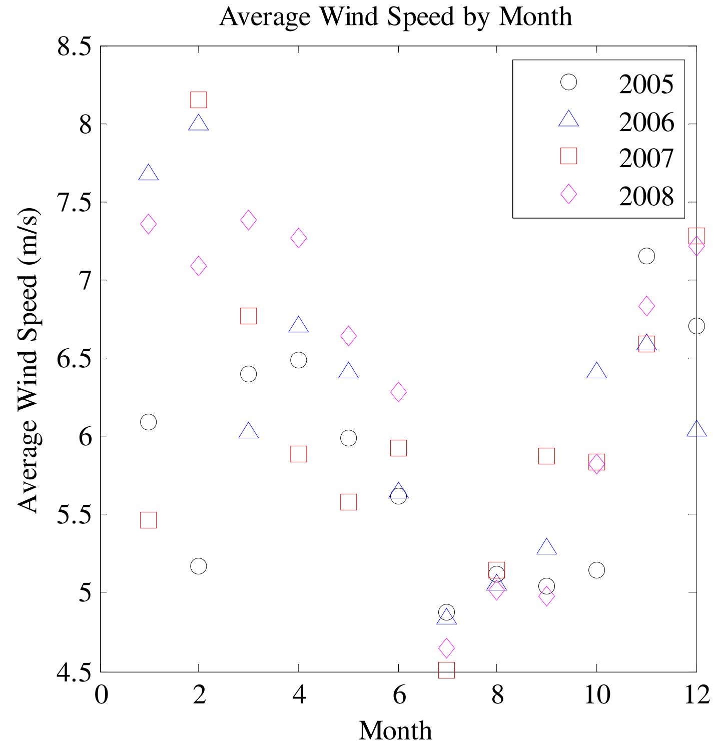
B. Wind Motion

3. Time Variation

SEASONAL VARIATIONS

SIGNIFICANT CHANGES OVER COURSE OF YEAR ARE COMMON

EXACT CAUSE VARIES



> 1 YEAR VARIATIONS

CLIMATE SHIFTS OCCUR

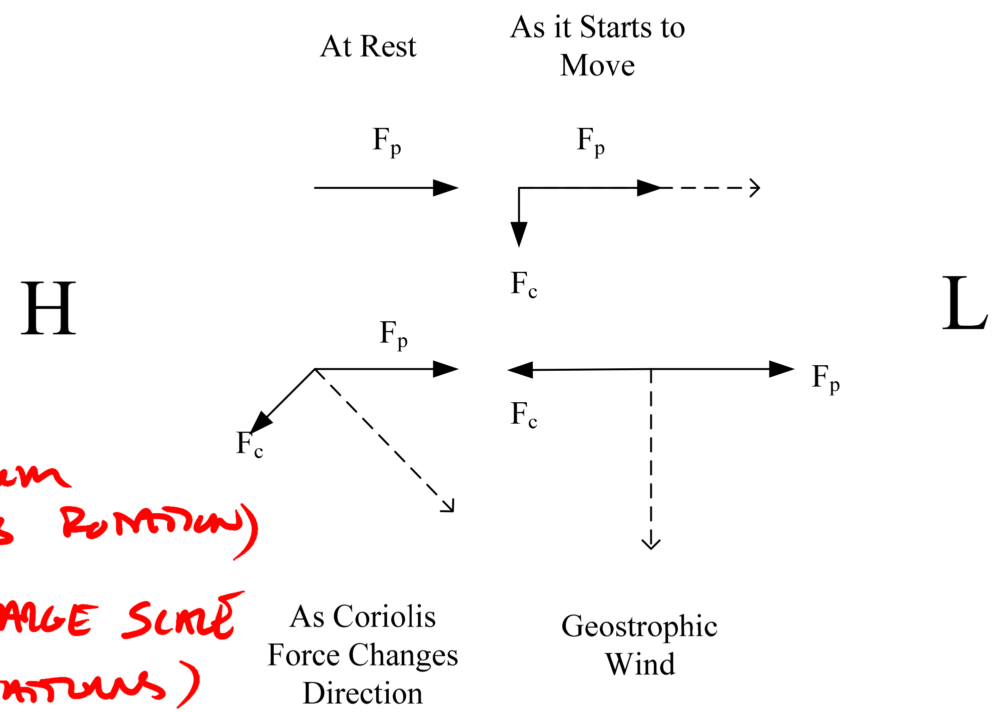
Wind Resource

B. Wind Motion

4. Mechanics

CONSIDER 4 FORCES ACTING ON A FLUID

- PRESSURE FORCES
- CORIOLIS FORCE (ARISES FROM EARTH'S ROTATION)
- INERTIAL FORCES (DUE TO LARGE SCALE WIND PATTERNS)
- FRICTIONAL FORCES

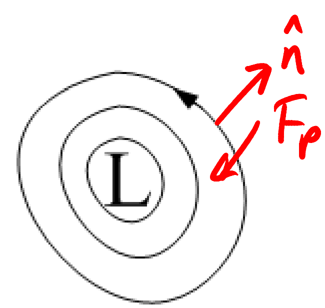


PRESSURE FORCES

$$\frac{F_p}{m} = -\frac{1}{\rho}\frac{\partial p}{\partial n}$$

$\frac{\partial p}{\partial n}$ = PRESSURE GRADIENT NORMAL TO THE ISOBARS

ρ = DENSITY



Wind Resource

B. Wind Motion

4. Mechanics

CORIOLIS FORCES

$$\frac{F_c}{m} = fU$$

← NOTE WIND FOR
BE PRESENT
CORIOLIS F TO DEVELOP

$f \equiv$ CORIOLIS PARAMETER

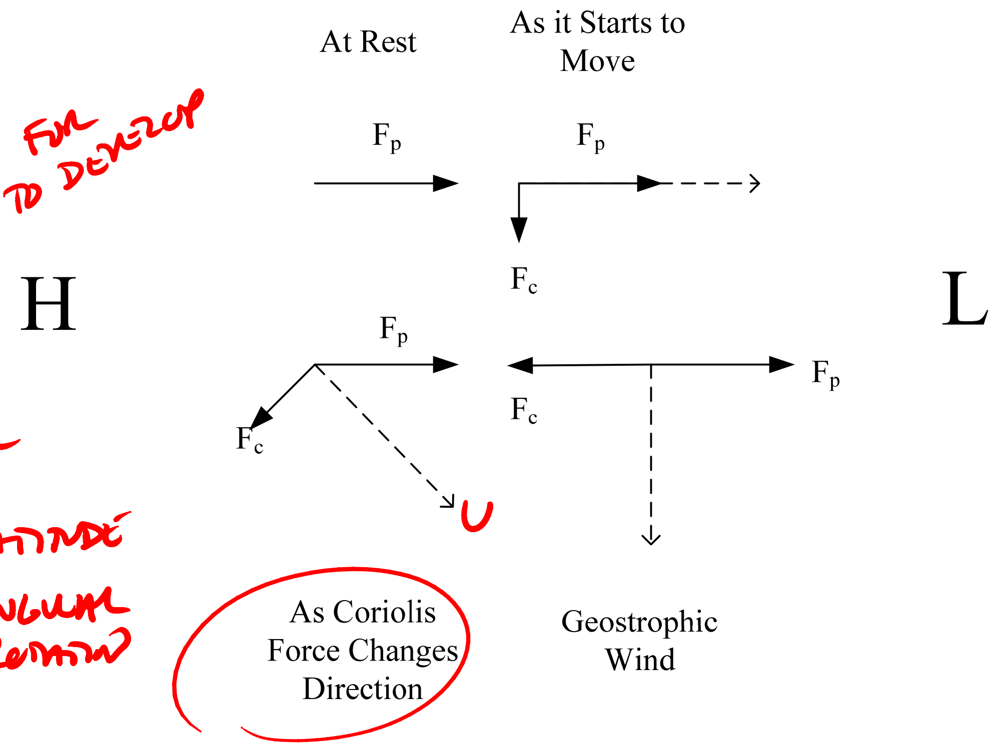
$f = 2\omega \sin(\phi)$ $\quad \phi$ - LATITUDE

ω - ANGULAR ROTATION

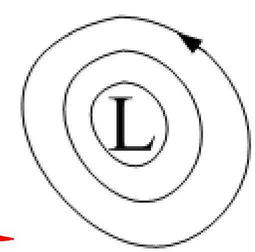
ACTS PERPENDICULARLY TO WIND DIRECTION

$$0 = \frac{F_p}{m} - \frac{F_c}{m}$$

$$0 = -\frac{1}{\rho}\frac{\partial p}{\partial n} - fU_g$$



U_g IS GEOSTROPHIC WIND



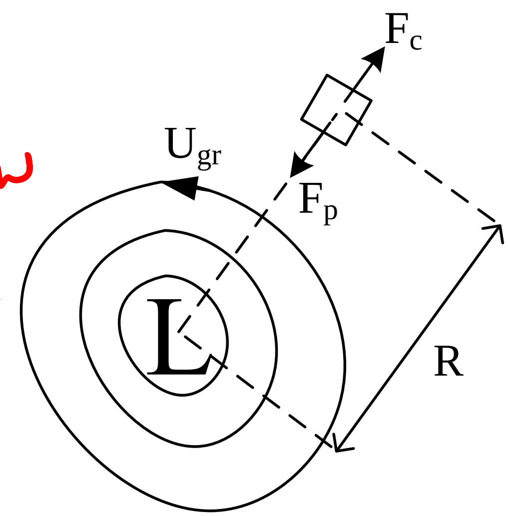
Wind Resource

B. Wind Motion

4. Mechanics

INERTIAL FORCES

DUE TO LARGE SCALE ROTATION PRESSURE & CORIOLIS WILL HAVE A SLIGHT DIFFERENCE



"INERTIAL FORCE"

$$\frac{U_{gr}^2}{R} = \frac{F_p}{m} - \frac{F_c}{m}$$

$$\frac{U_{gr}^2}{R} = -\frac{1}{\rho}\frac{\partial p}{\partial n} - fU_{gr}$$

FROM BEFORE

$$0 = -\frac{1}{\rho}\frac{\partial p}{\partial n} - fU_g$$

COMBINE TO SHOW

$$\frac{U_{gr}^2}{fR} + U_{gr} = U_g$$

FRICTIONAL FORCES

IN THE LOWEST PART OF THE ATMOSPHERE, FRICTIONAL FORCES DEVELOP

NO-SLIP, VISCOSITY $\Big\}$ $\Rightarrow$ CONFINED TO THE BL