Wind Resource

C. Atmospheric Boundary Layer

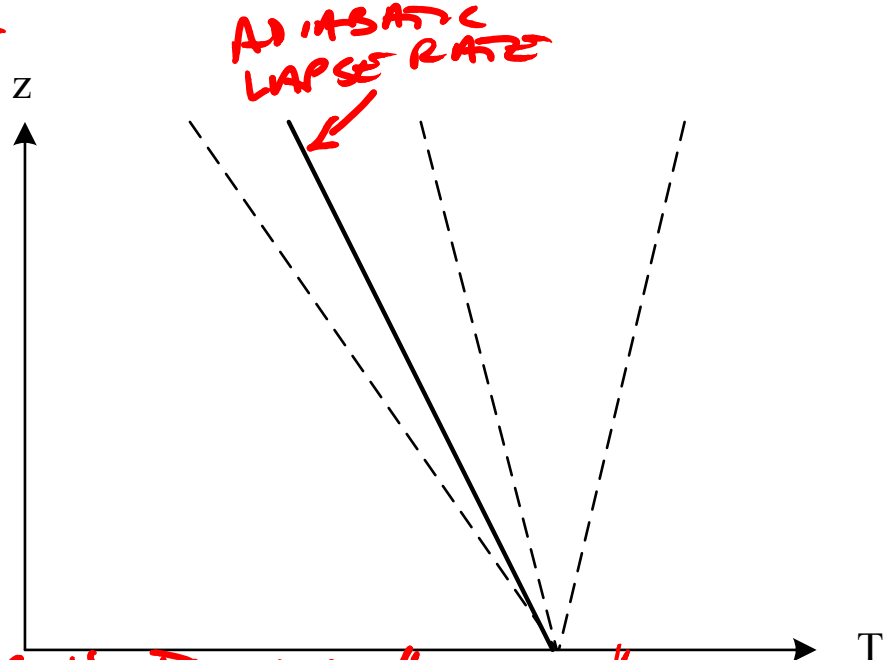
4. Vertical Variation of Temperature and Stability

STABILITY OF THE BL HAS A LARGE IMPACT ON SURFACE WINDS

HYDROSTATICS & FIRST LAW

$$\left(\frac{dT}{dz}\right)_{ADIABATIC} = -g\frac{1}{c_p}$$

$$= -0.0098\ \frac{K}{m}$$



CONSIDER STABILITY

ASK THE QUESTION OF WHAT HAPPENS TO AIR "PACKET" IF IT IS DISPLACED UPWARD

NOTHING – NEUTRALLY STABLE

RETURN TO WHERE IT CAME FROM – STABLE

MOVE AWAY FROM WHERE IT CAME – UNSTABLE

Wind Resource

C. Atmospheric Boundary Layer

4. Vertical Variation of Temperature and Stability

DAY TIME → WARM GROUND, COOL AIR, UNSTABLE

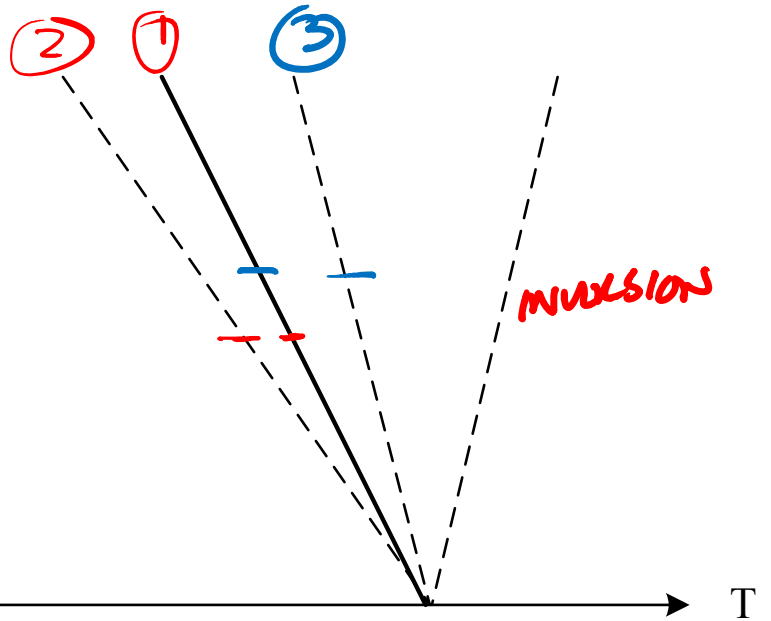
NIGHT TIME → COOL GROUND, WARM AIR, STABLE

CONSIDER BALL ON SURFACE

FOR ATMOSPHERE

MOVE PARCEL UPWARD TO LOCATION WITH LOWER PRESSURE

PARCEL COOLS AT ADIABATIC LAPSE RATE



① IF SURROUNDING AIR ALSO COOLS AT ADIABATIC LAPSE RATE PARCEL & SURROUNDING AT SAME TEMP → NEUTRALLY STABLE

② IF SURROUNDING AIR COOLS AT A FASTER RATE → UNSTABLE

③ IF SURROUNDING AIR COOLS AT A SLOWER RATE → STABLE

Wind Resource

C. Atmospheric Boundary Layer

4. Terrain Effects

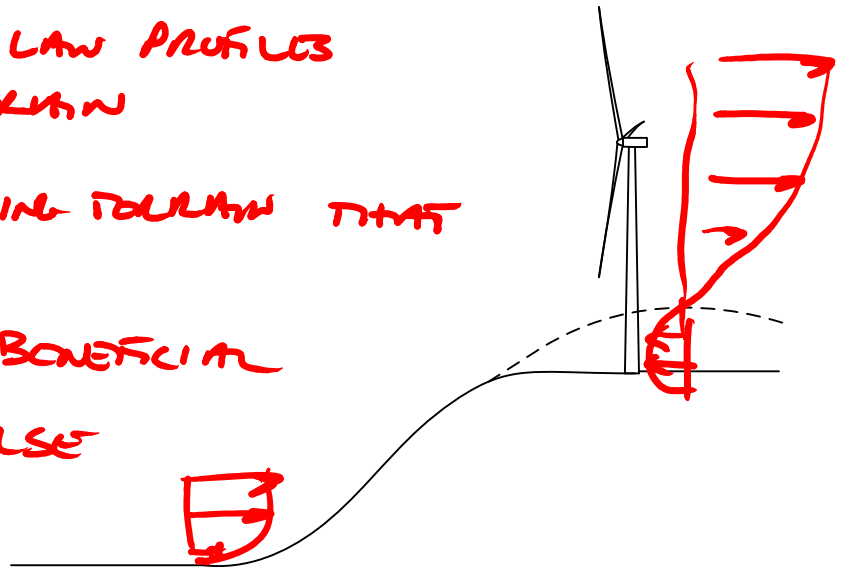
SIMPLE POWER LAW & LOG LAW PROFILES PERTAIN ONLY TO FLAT TERRAIN

MANY WIND SITES HAVE VARYING TERRAIN THAT WILL AFFECT WINDS

SOME TERRAIN FEATURES ARE BENEFICIAL

OTHER EFFECTS ARE ADVERSE

SOME HAVE BOTH !



SMALL SCALE
HILLS & DEPRESSIONS ← WIND DIRECTION PLAYS IMPORTANT ROLE

LARGE SCALE
VALLEYS & CANYONS
GAPS & GORGES
BASIN

Wind Resource

C. Atmospheric Boundary Layer

4. Terrain Effects

WINDS ENCOUNTERING "OBSTACLES"

USUALLY THESE ARE MAN MADE BUILDINGS HOUSES

PRODUCE SIMILAR FEATURES

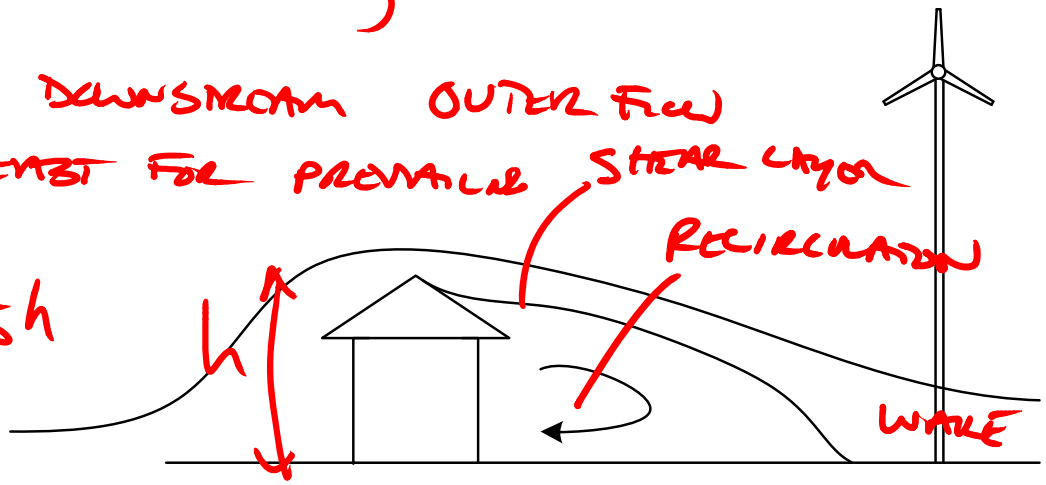
EFFECTS OF OBSTACLES

INCREASE TURBULENCE

DECREASE IN VELOCITY

TRY TO AVOID BEING DOWNSTREAM OUTER FLOW OF OBSTACLES – AT LEAST FOR PREVAILING WIND DIRECTION

BE GREATER THAN 15h DOWNSTREAM



Wind Resource

D. Characterization of the Wind

1. Introduction

WIND RESOURCE CHARACTERIZATION IS CRITICAL TO ALL FACETS OF WIND ENERGY INDUSTRY

DISCUSSION FOCUS ON MEANS OF QUANTIFYING WIND RESOURCE

- WIND SPEED
- WIND DIRECTION
- WIND VARIABILITY

POWER IN THE WIND

2. Wind Speed and Direction

FIRST STEP → AVERAGE WIND SPEED & DIRECTION

- AFFECT POWER OUTPUT ESTIMATION
- SITING

SOURCES FOR THIS INFORMATION → DISCUSSED LATER

SEVERAL DIFFERENT SCALES EXIST FOR DESCRIBING WIND SPEED

Wind Resource