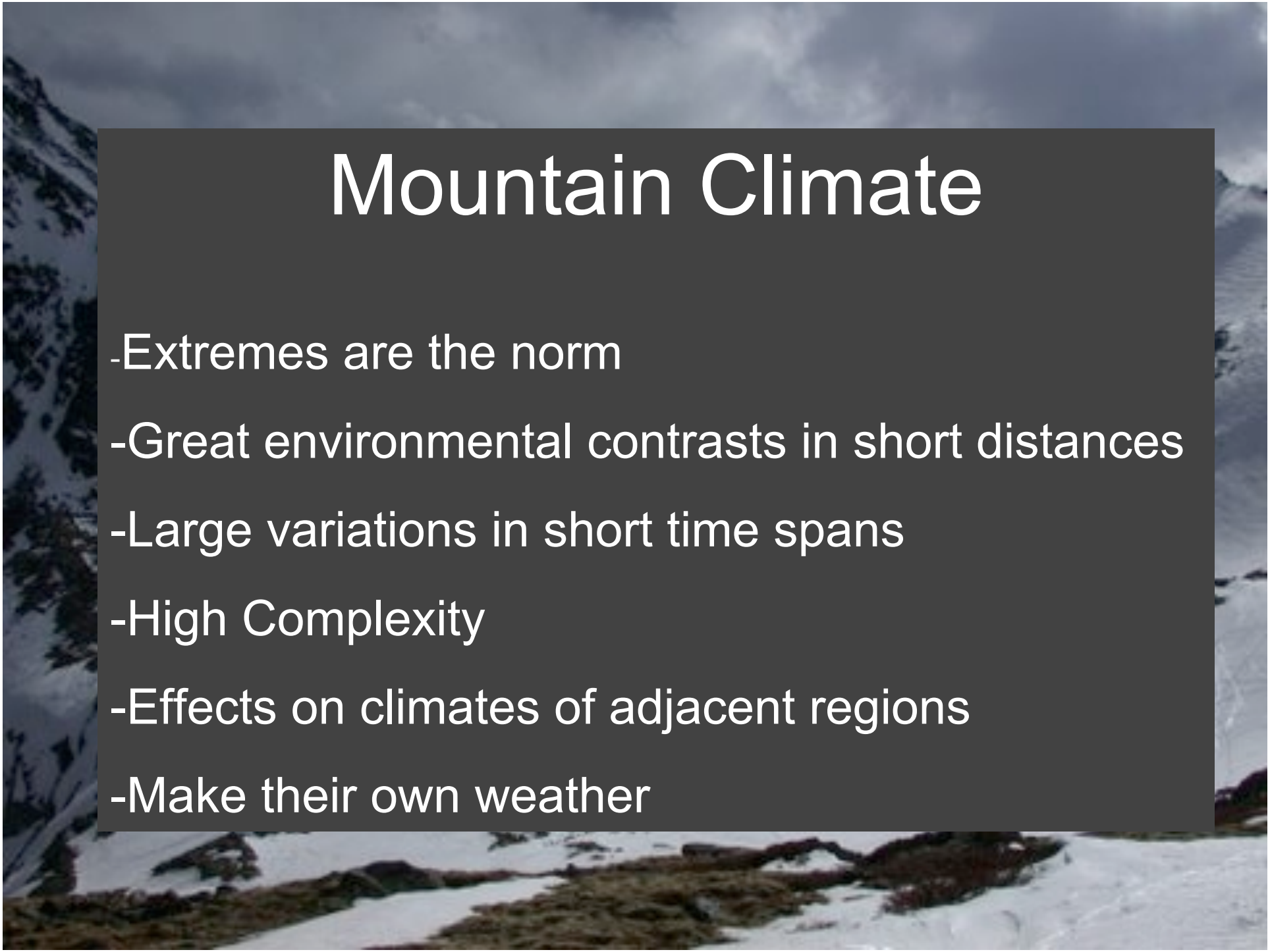


Mountain Climate

-Extremes are the norm

-Great environmental contrasts in short distances

-Large variations in short time spans

-High Complexity

-Effects on climates of adjacent regions

-Make their own weather

Four Major Climatic Controls

1. Altitude
2. Latitude
3. Topography
4. Continentality

Scales in Mt.Climate

	Micro-Scale	Local-Scale	Regional-Scale
Meteorology Phenomena	Turbulent Motion (gusts)	Slope and Valley winds	Thunderstorms
Landscape Elements	Rocks; Vegetation Clumps	Terrain Elements (slopes,valleys)	Mountain Ranges
Climatic Features	Snow patches	Radiational Contrasts, thermal belts	Monsoons

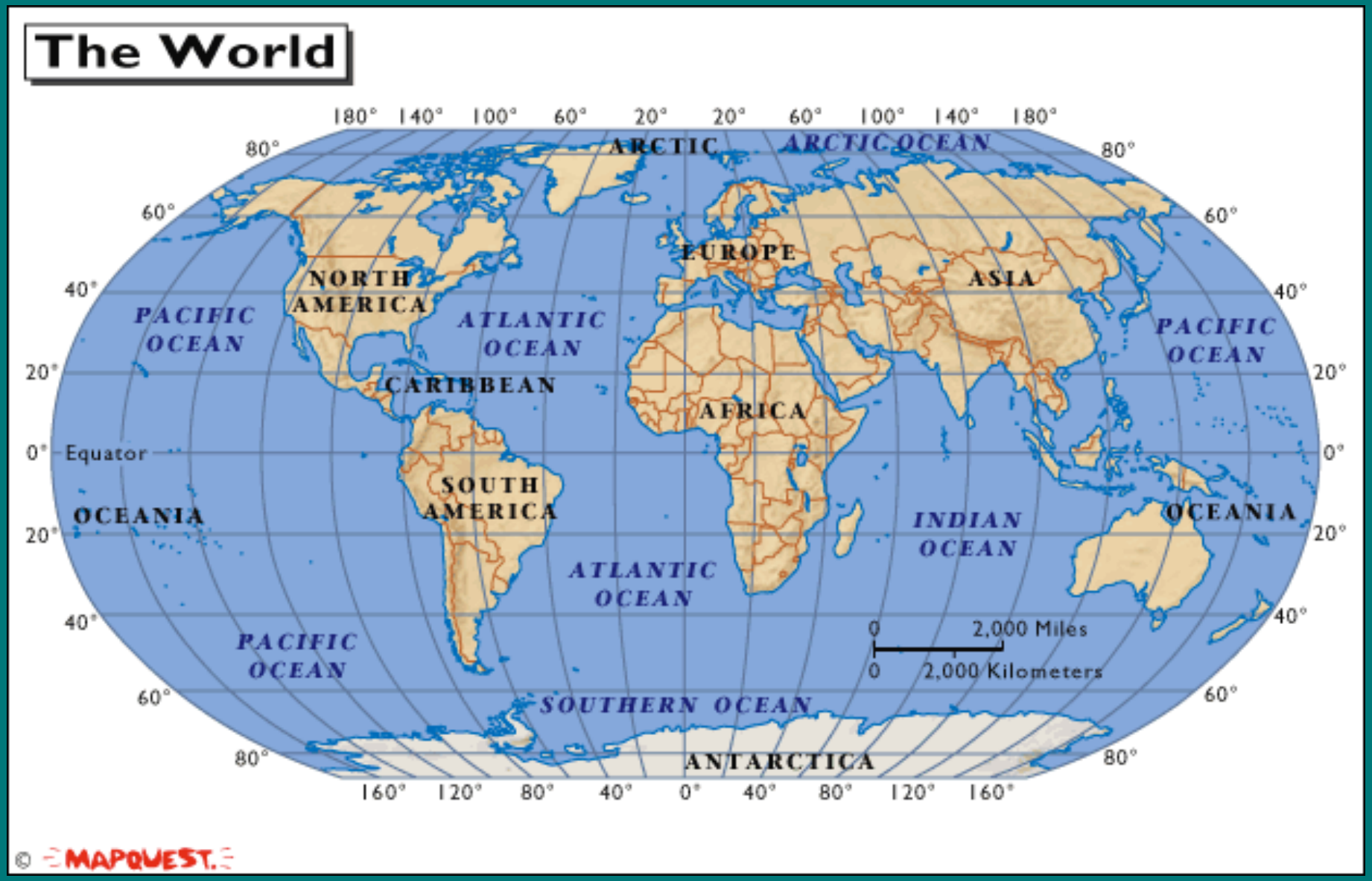
Altitude vs. Latitude

- Given as separate climatic controls
- Is this really true?

Old saying:

"Gaining elevation on a mountain is the same as gaining latitude"

Altitude vs. Latitude



ALTITUDE

4 Key Variables

1. Air pressure, density, and oxygen
2. Atmospheric Water Vapor
3. Temperature
4. Solar Radiation
    - -Quality
    - -Quantity

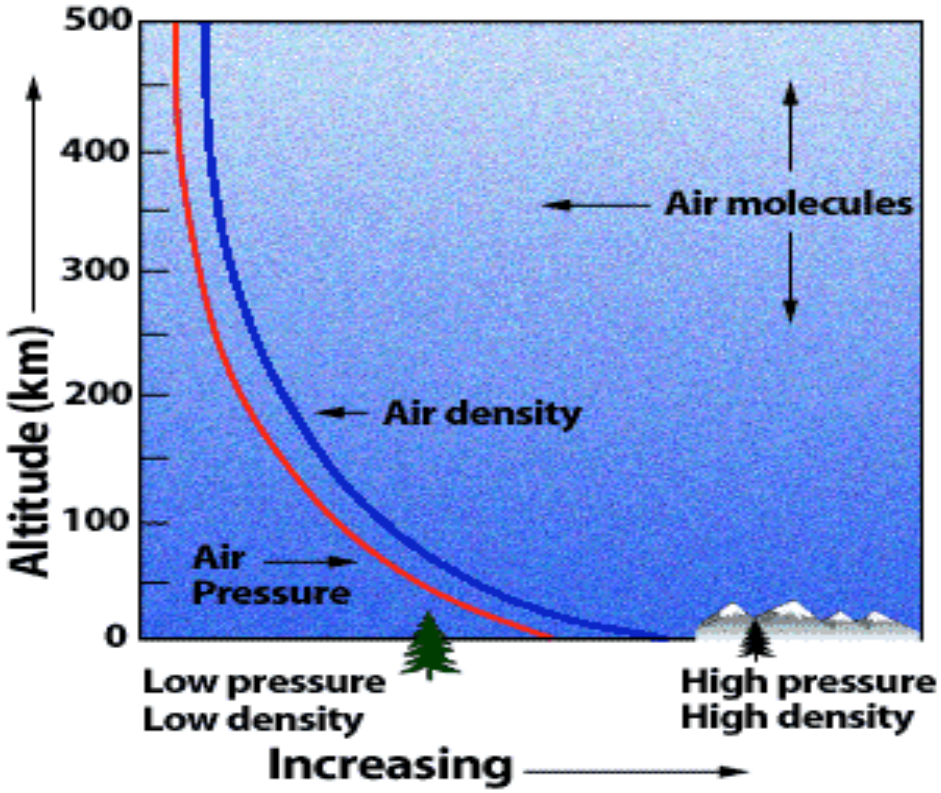
Air pressure, Density, Oxygen

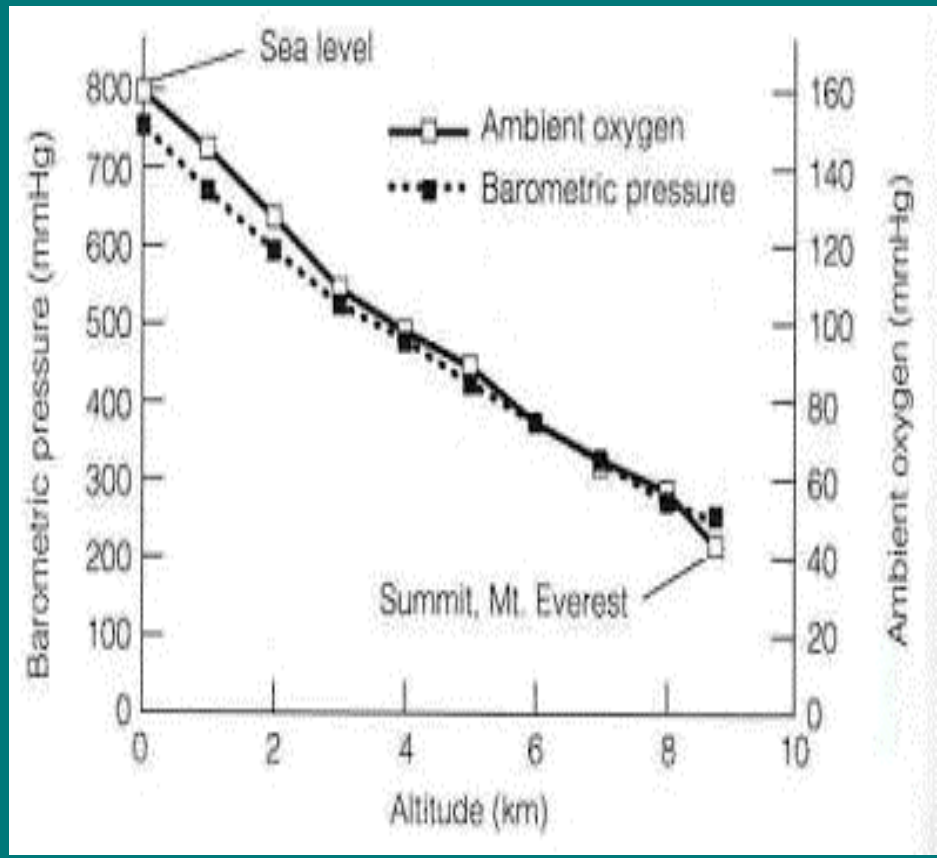
-Decrease with increasing altitude

-Exponential relationship

-5.5 km (~3.5mi), lose ½ atm pressure

-8 km (~5mi), lose 70% atm pressure


500
400
300
200
100
0
Altitude (km)
Air molecules
Air density
Air
Pressure
Low pressure
Low density
High pressure
High density
Increasing

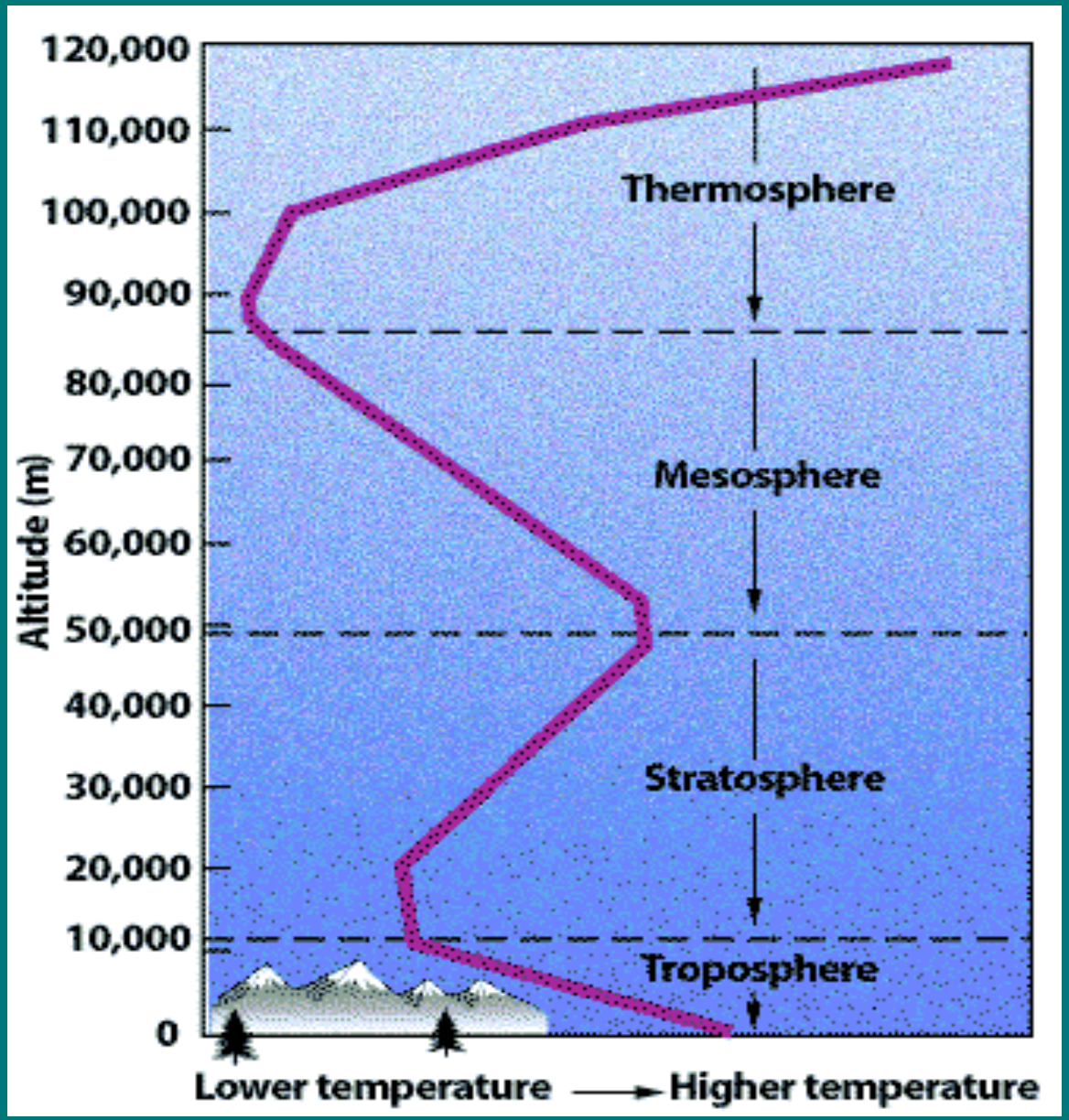

Sea level
Ambient oxygen
Barometric pressure
Summit, Mt. Everest
Barometric pressure (mmHg)
Ambient oxygen (mmHg)
Altitude (km)
800
700
600
500
400
300
200
100
0
160
140
120
100
80
60
40
20
0
0
2
4
6
8
10

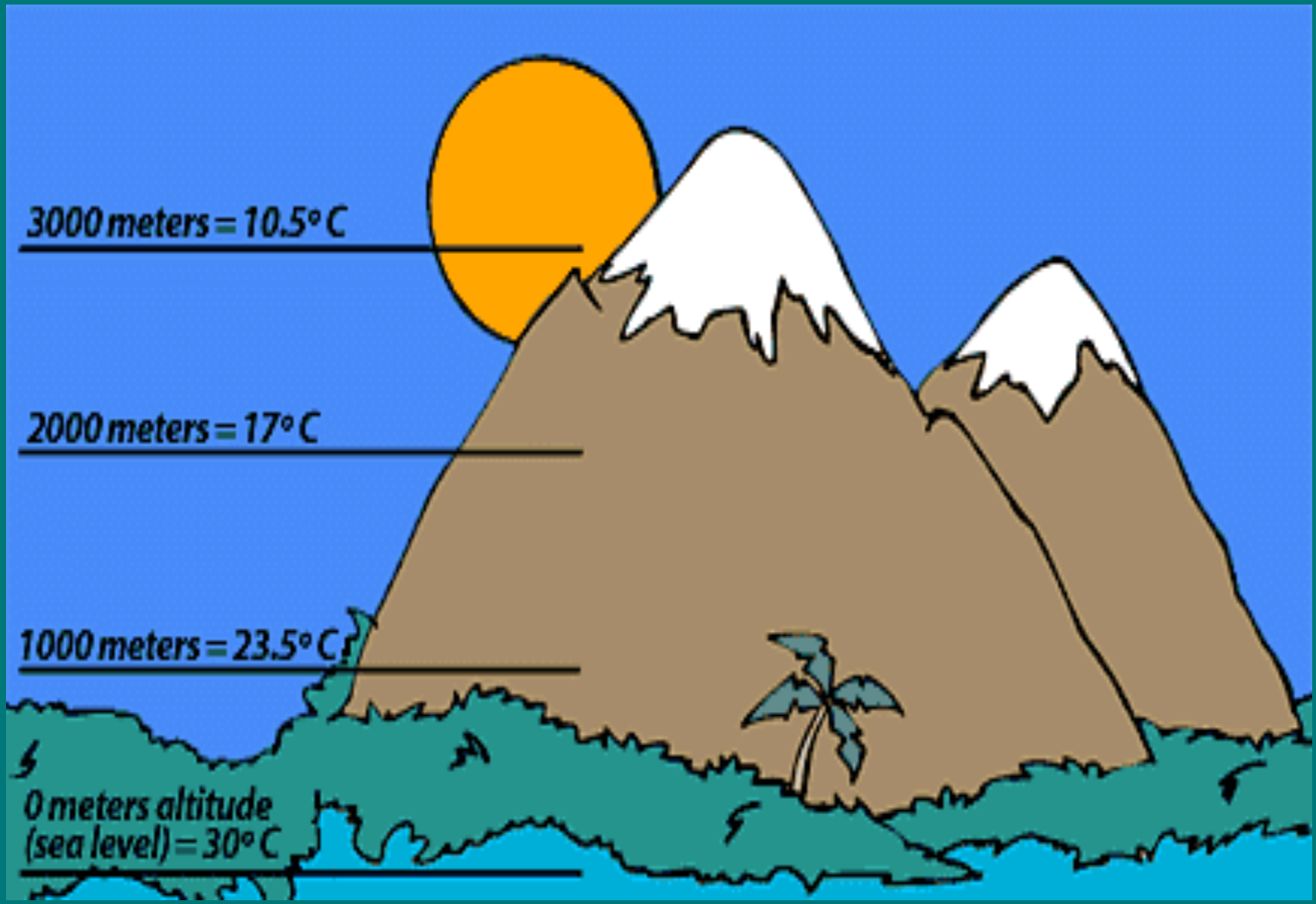
Atmospheric Water Vapor

- Decreases with increasing altitude
- Absolute humidity
  - The density of water in a particular volume of air.
- Specific humidity
  - The mass of water vapor per unit mass of air .

Temperature

- Decreases with increasing altitude
- Lower air density and water vapor
- Lapse rate
  - Moist: 6.5ºC /1000m
  - Dry: 10ºC/1000m
- Temperature Inversions

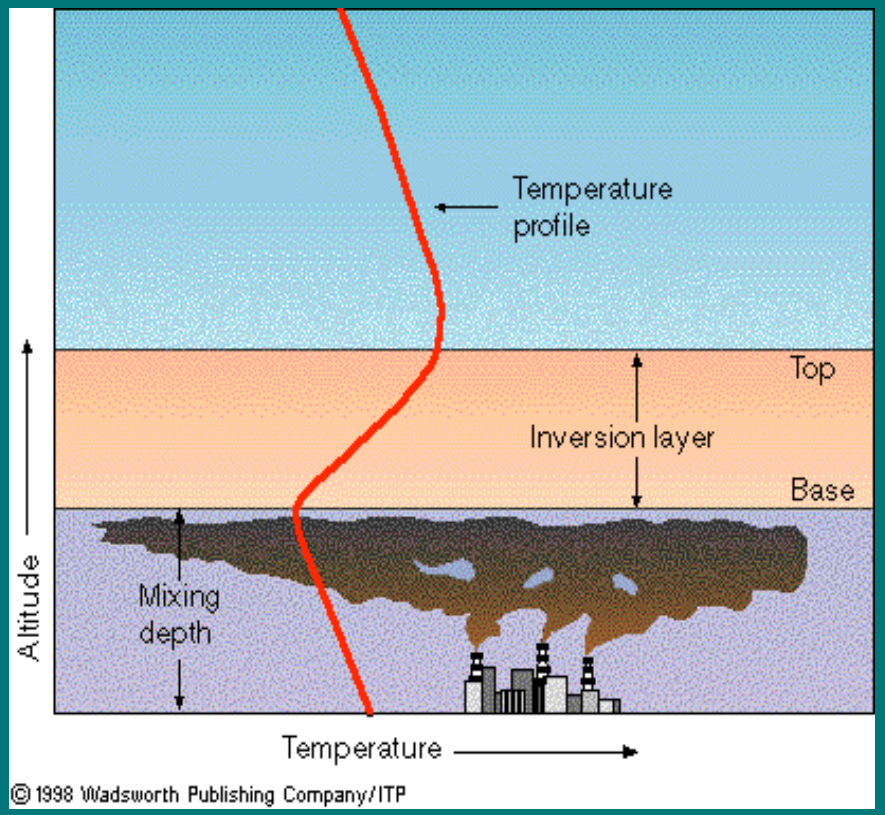

120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Altitude (m)
Thermosphere
Mesosphere
Stratosphere
Troposphere
Lower temperature
Higher temperature


3000 meters = 10.5° C
2000 meters = 17° C
1000 meters = 23.5° C
0 meters altitude
(sea level) = 30° C

Temperature Inversions

- Colder air=more dense=sinking
- Ideal Conditions
  - Calm skies, no mixing
  - Clear skies
  - Enclosed valley

  collects stagnant air



Salt Lake City, Utah

Solar Radiation (Quantity)

- Most extreme and variable radiation on earth
- Increased radiation with increased altitude
- Atmosphere acts as a filter because of:
  - Water vapor
  - Particulates
  - CO_2
- These all absorb solar radiation, decreasing solar energy

Solar Radiation (Quality)

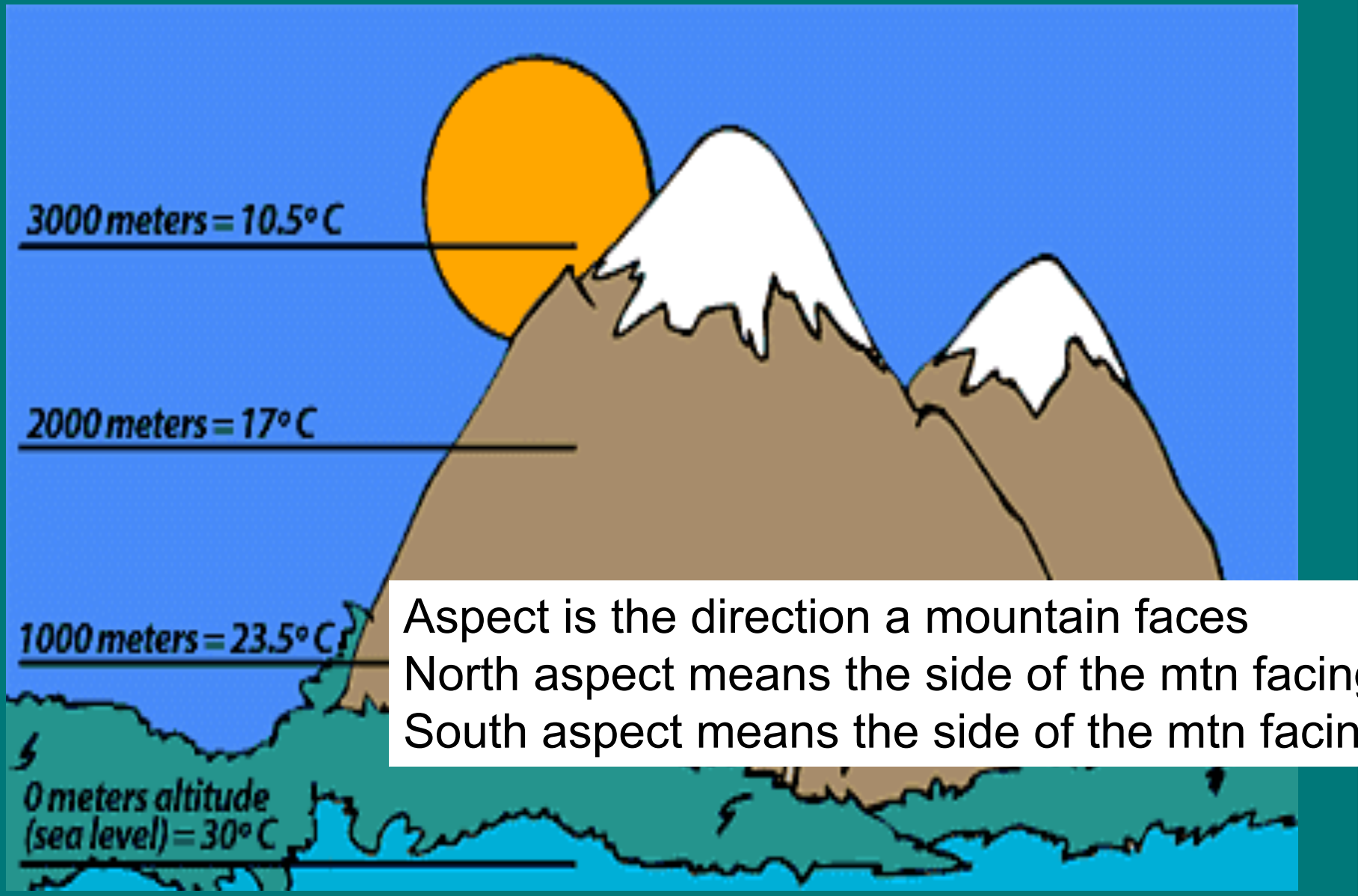
- ↑shortwave radiation w/ ↑altitude
- Ultraviolet (UV) Problems
- Considerably more UV at alpine that sea level
- Ozone traps UV
- One reason why sunburns so frequent at high elevation
- Plants must adapt to high UV

Back to scale…. Radiation/Temp

Regional → Δ Diurnal/seasonal

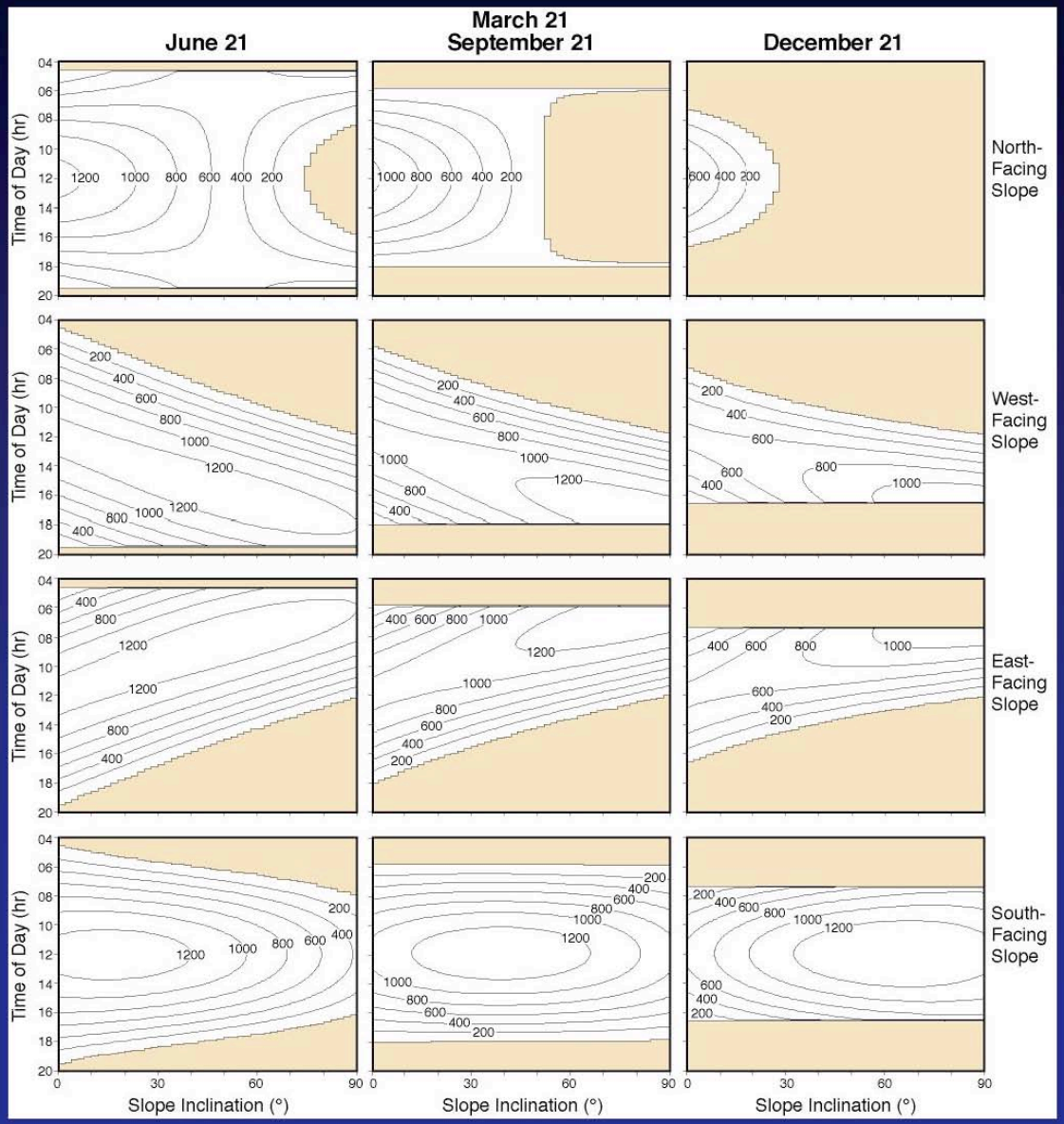
Local → Aspects

Micro → Tanning areas



Aspect is the direction a mountain faces
North aspect means the side of the mtn facin
South aspect means the side of the mtn facin

Extraterrestrial solar radiation on slopes



Whiteman (2000)

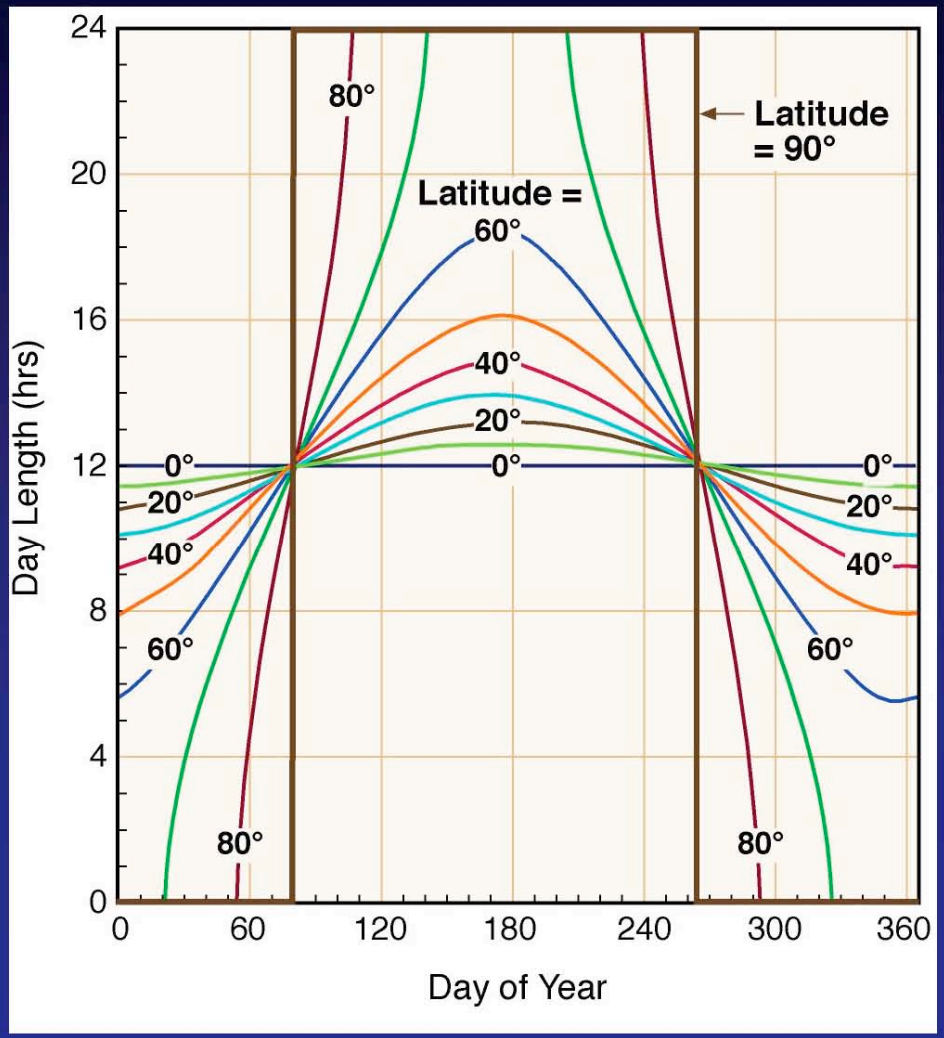
Solar Radiation: Aspect and Slope Angle

- Mid-latitude, northern hemisphere
- Winter: north-facing slopes little sun
  - South-facing slopes at about 30º receive almost as much solar radiation as during the summer
- Very large differences in solar radiation in mountains, depending on aspect and slope angle

Latitude

- Determines length of day and angle of incoming sunlight and, thus, amount of solar radiation received
  - In equatorial regions, day length & solar angle change little with season. Little seasonal variability, mostly diurnal changes.
  - In polar regions, the sun does not rise at all in winter. In the summer it never sets, although remaining low in sky. Big seasonal changes, small diurnal changes.
  - In mid-latitudes, seasonal and diurnal changes.
- Also determines site's exposure to latitudinal belts of high and low pressure
  - High pressure - subsidence
  - Low pressure - convection

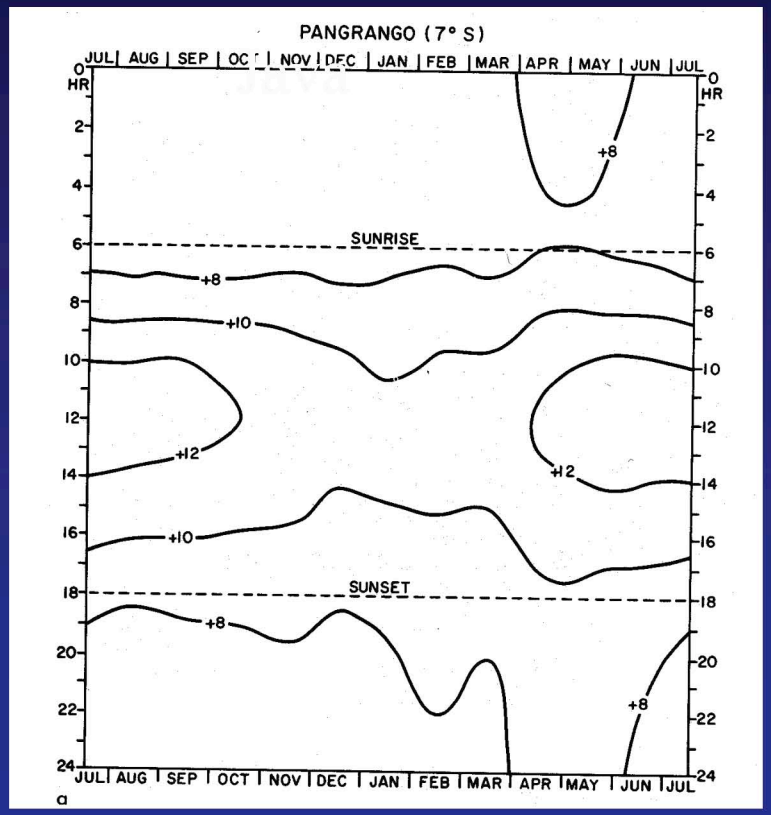
Day length vs latitude



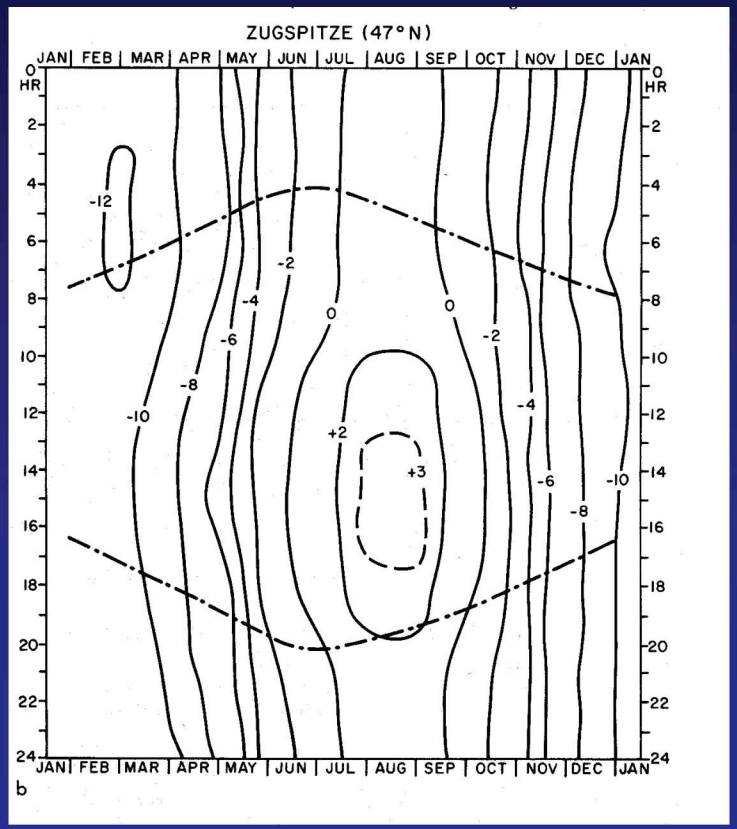
Whiteman (2000)

Temperature: Annual vs. Diurnal

Indonesia



Germany



Barry (1992)

Impacts of Latitude

- Net radiation (incoming – outgoing) and temperature decrease as latitude increases
- Elevation of treeline/snowline decreases poleward
- Belt of alpine vegetation and permanent snow and ice are lower on mountains at high latitude versus the tropics

Snow lines and timberlines

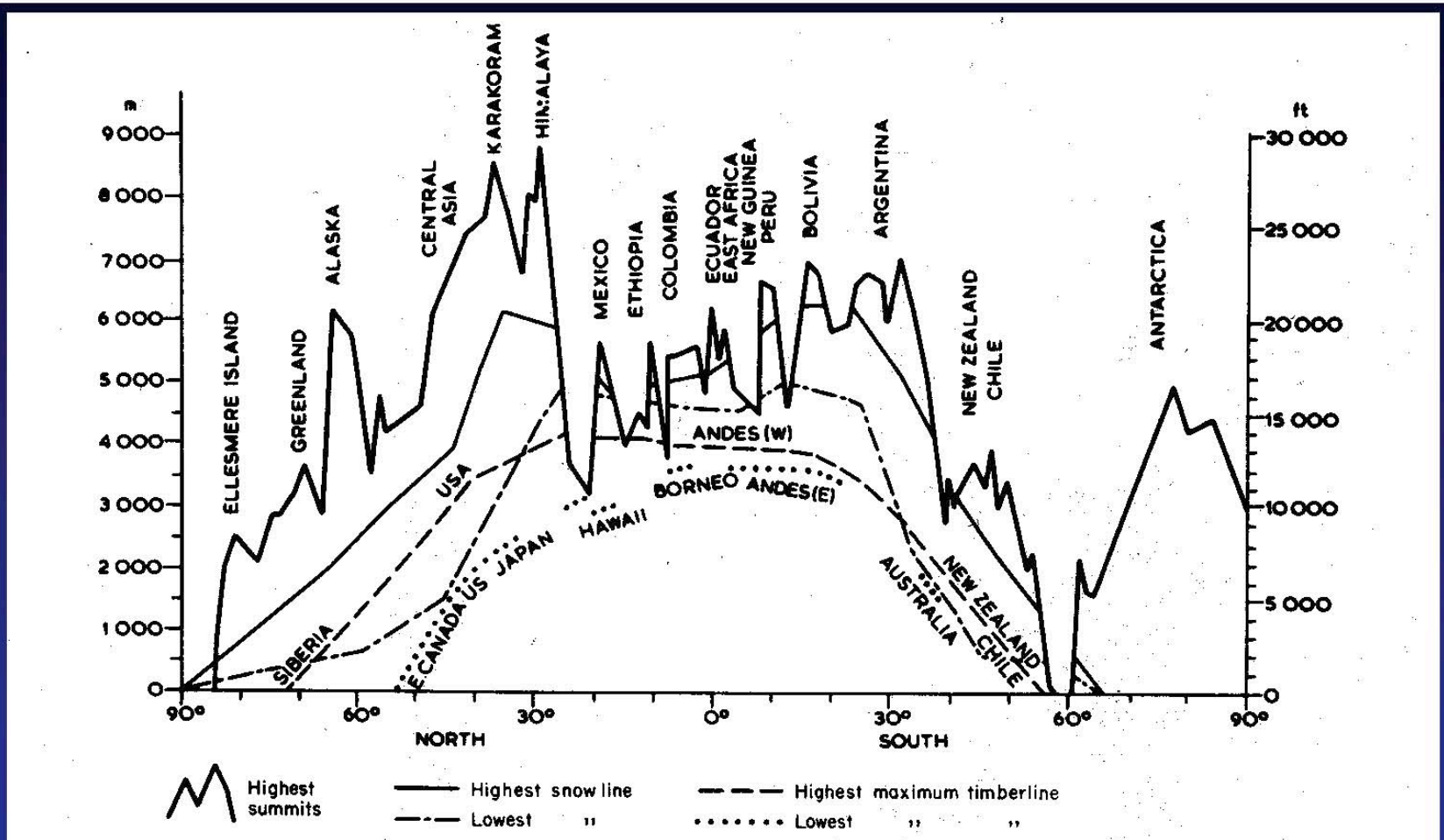
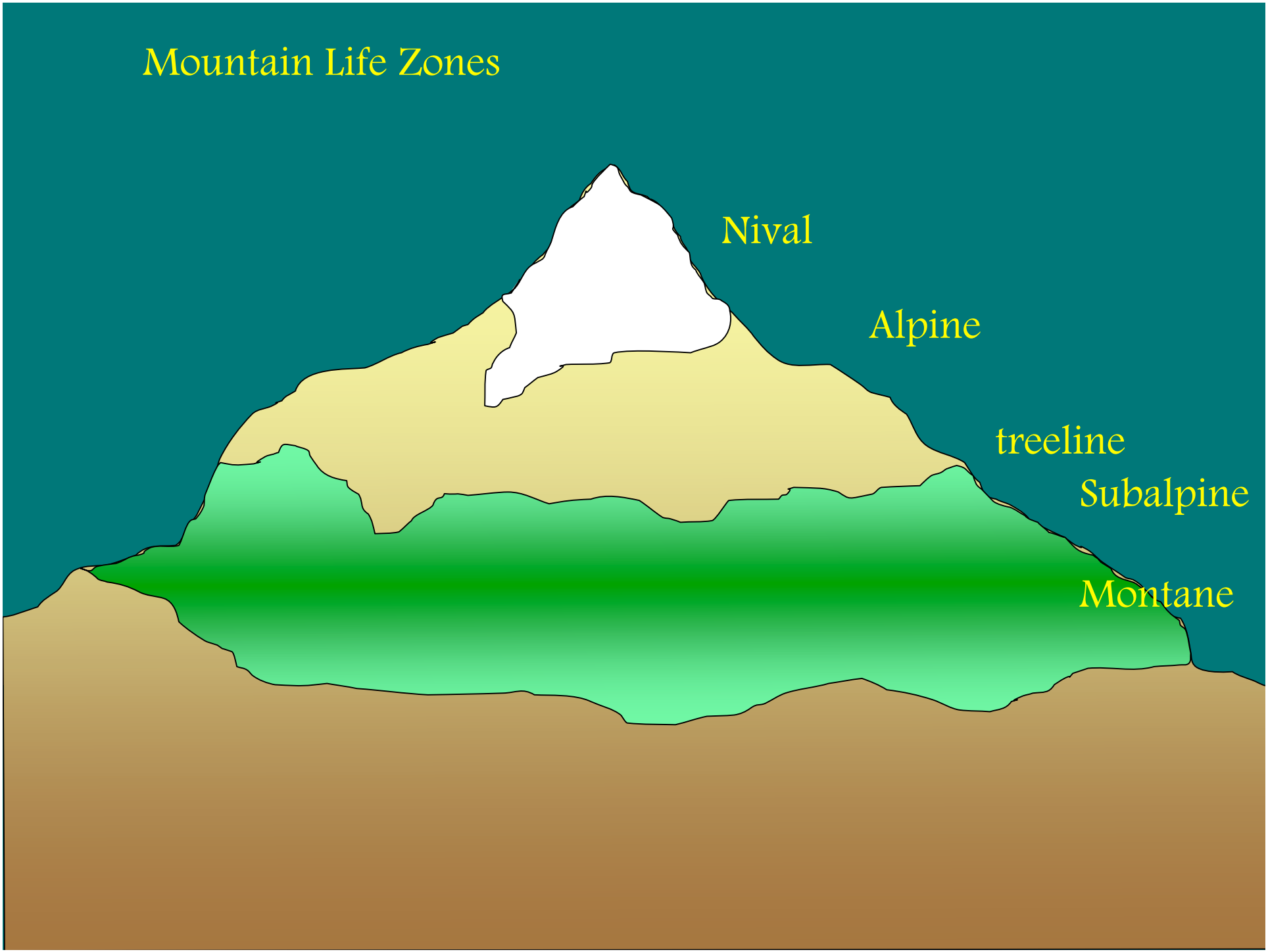


Figure 1.1 Latitudinal cross-section of the highest summits, highest and lowest snow lines, and highest and lowest upper limits of timber line. (From Barry and Ives, 1974.)

“Gaining elevation on a mountain is the same as gaining latitude”

True or false?

Evidence?


Mountain Life Zones
Nival
Alpine
treeline
Subalpine
Montane