

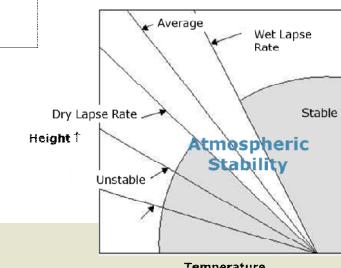
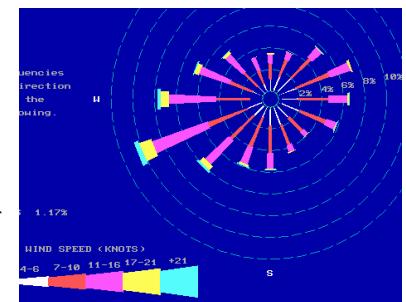
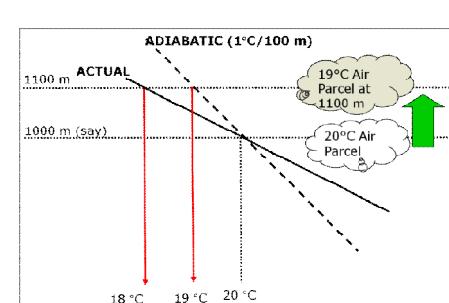
Lecture 5

Air Quality:

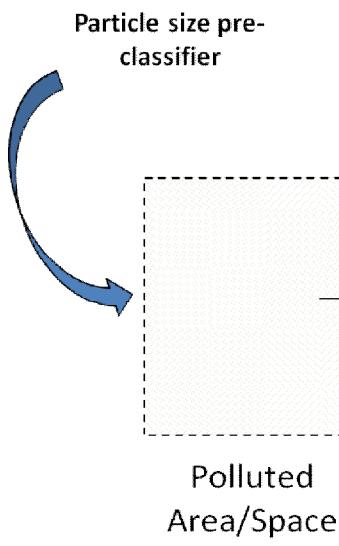
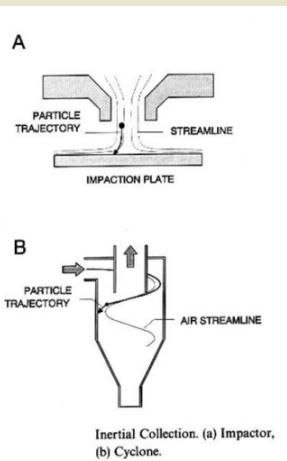
Effect of Meteorology on Pollutants Dispersion

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Recap 1

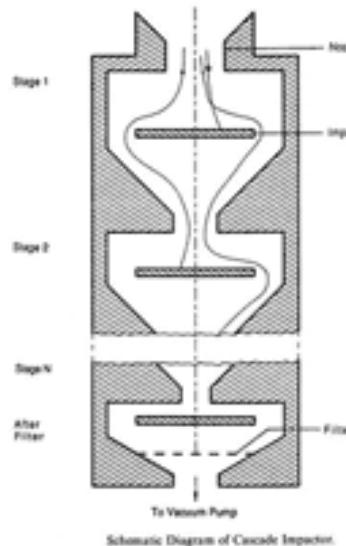


$$C = \Delta m / Q \cdot t$$

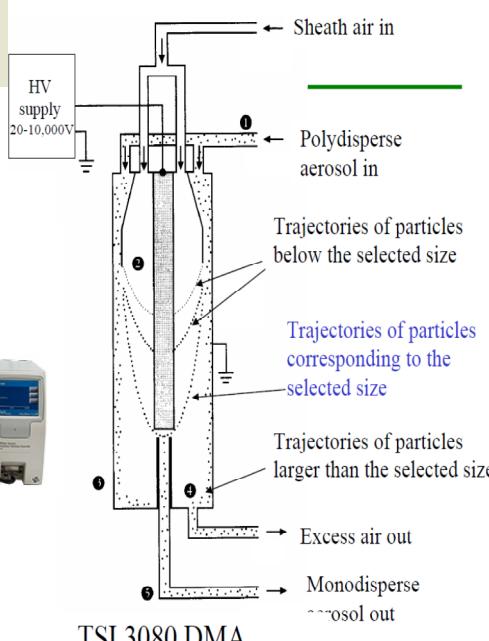


Choice of instruments is a function of its cost, intended analysis, time resolution, portability, ease of use

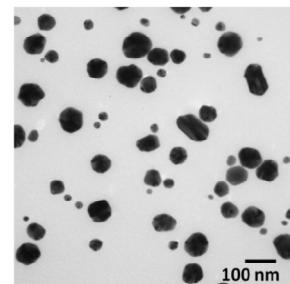
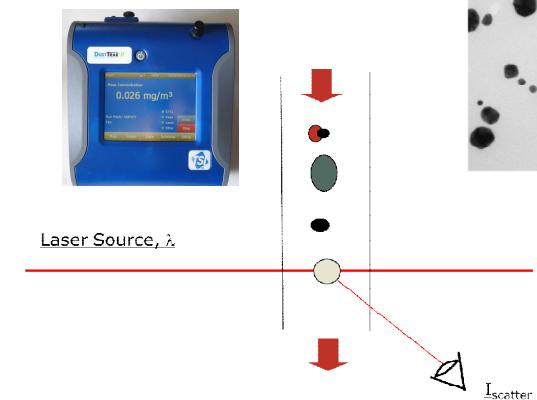
Recap 2



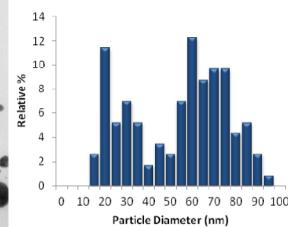
Anderson six-stage viable impactor



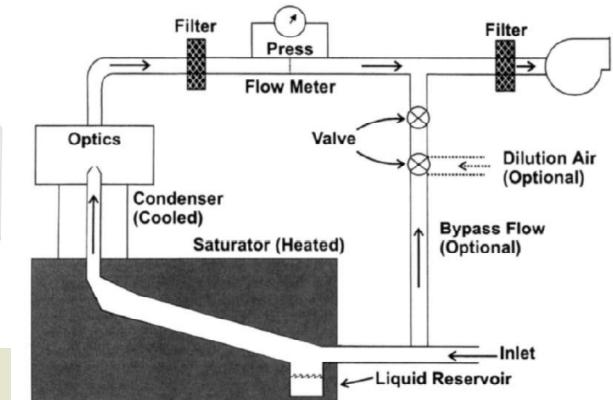
TSI 3080 DMA



Size Distribution



Ultrafine Condensation Particle Counter



Today's Learning Objective !

- To explain effects of meteorology and the physics of dispersion of pollutants in the atmosphere

Types of Sources

- Point
- Line
- Area



Mixing/Dispersion

Meteorology

- Vertical
 - Temperature
 - Lapse Rate
- Horizontal
 - Wind
 - Speed
 - Direction

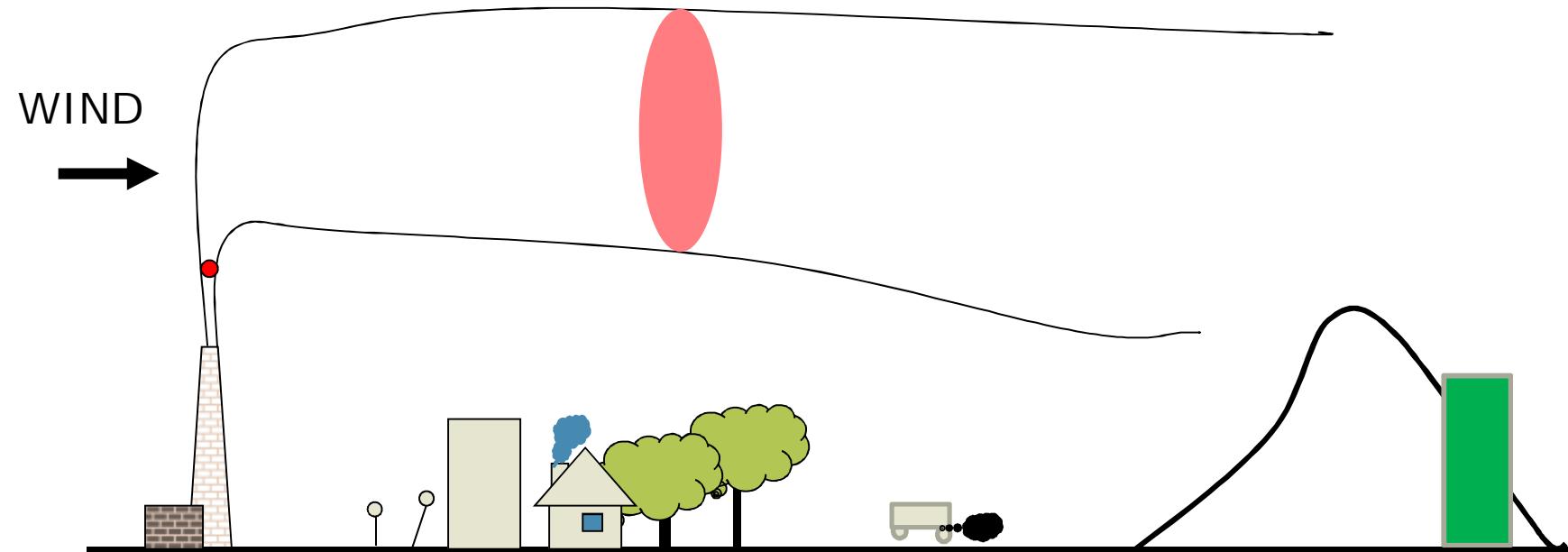
Other met. parameters

- Sunlight
- Precipitation
- Humidity

A number of following slides have been taken/adapted from Prof. Sethi's ES200 lectures from last years !

Dispersion – Gaussian Plume

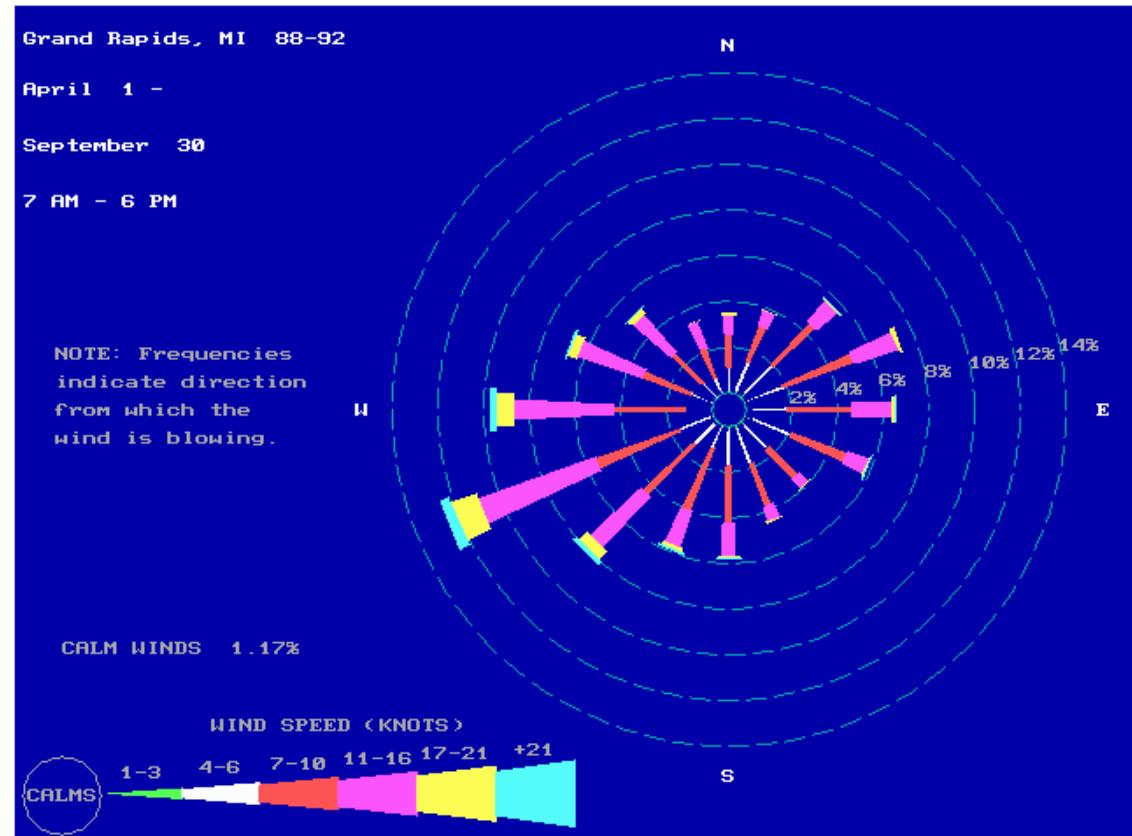
Higher the wind speeds, longer distance the pollutants carried to, but more quickly they will be cleared from an air space as well



Wind Rose

- Wind roses are divided into 16 wind directions
- Each wind direction is divided into wind speeds
- As the percent of time the wind blows from a particular directions gets larger, the portion of the bar representing the wind speed gets larger both in length and width

1 knot = 1.82 km/hr



<http://www.epa.gov/ttn/naaqs/ozone/areas/wind.htm#dlfi>

Wind Rose

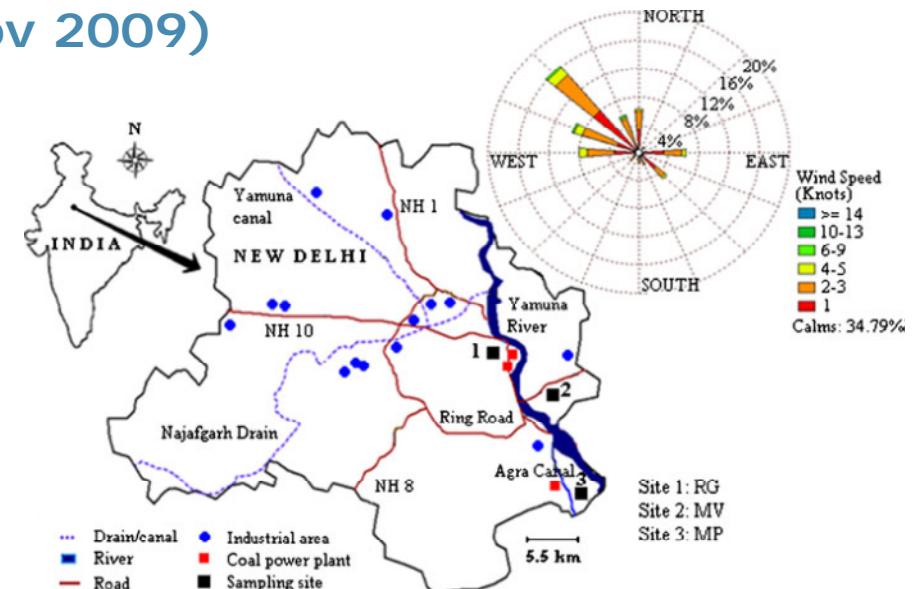
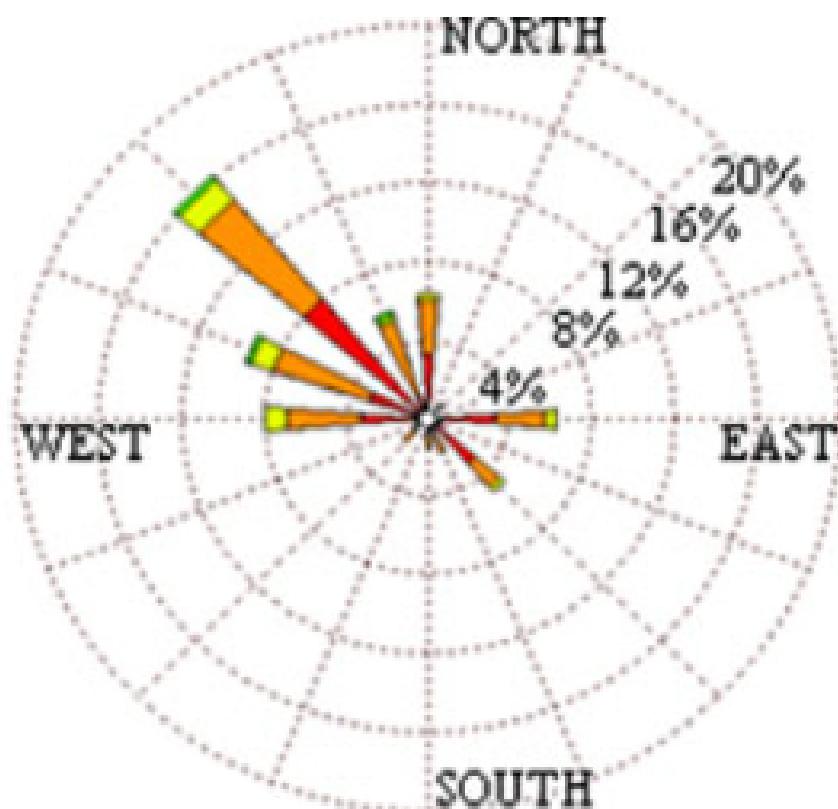
Wind profile of Mumbai on 31/Oct/2017



Wind Rose

1 knot = 1.82 km/hr

Wind profile Delhi (Dec 2008- Nov 2009)



Wind Speed
(Knots)

- ≥ 14
- 10-13
- 6-9
- 4-5
- 2-3
- 1

Calms: 34.79%

Wind Direction

Have you heard of the following?

- 'easterly winds' (*purvai*)
- 'westerly winds' (*pachhua*)

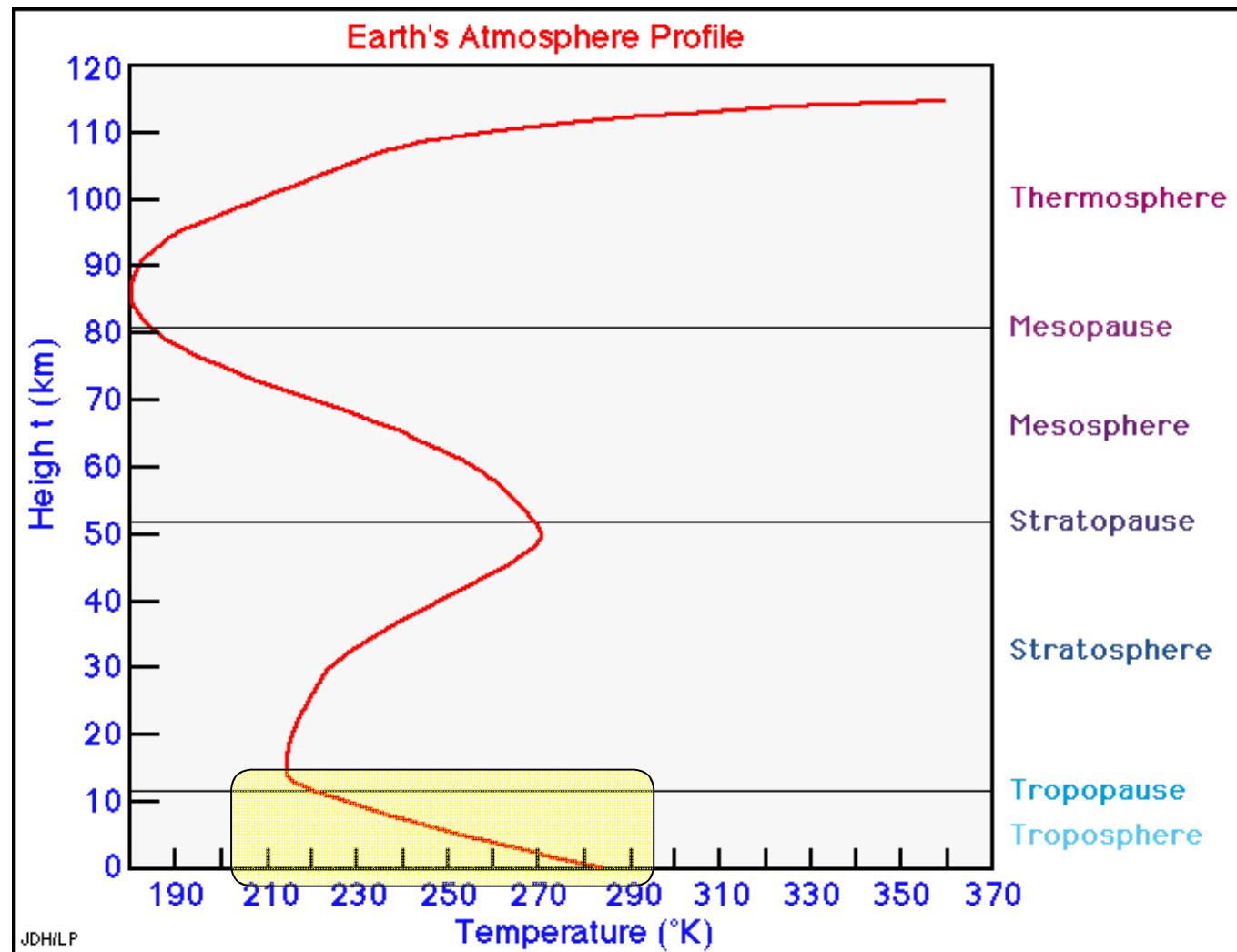
Pachhua is cold in winters and warm in summer. *Purvai*, on the other hand, has pleasant temperature. During pre-monsoon /monsoon, however, *Purvai* carries humidity, making the weather unbearable under the hot Sun.

Mixing/Dispersion

Meteorology

- Vertical
 - Temperature
 - Lapse Rate
- Horizontal
 - Wind
 - Speed
 - Direction

Atmospheric Temperature profile



<http://www.Ideo.columbia.edu/edu/dees/ees/climate/slides/atmprofile.gif>

Lapse Rates

Atmosphere (troposphere) cools with height

@what rate ?

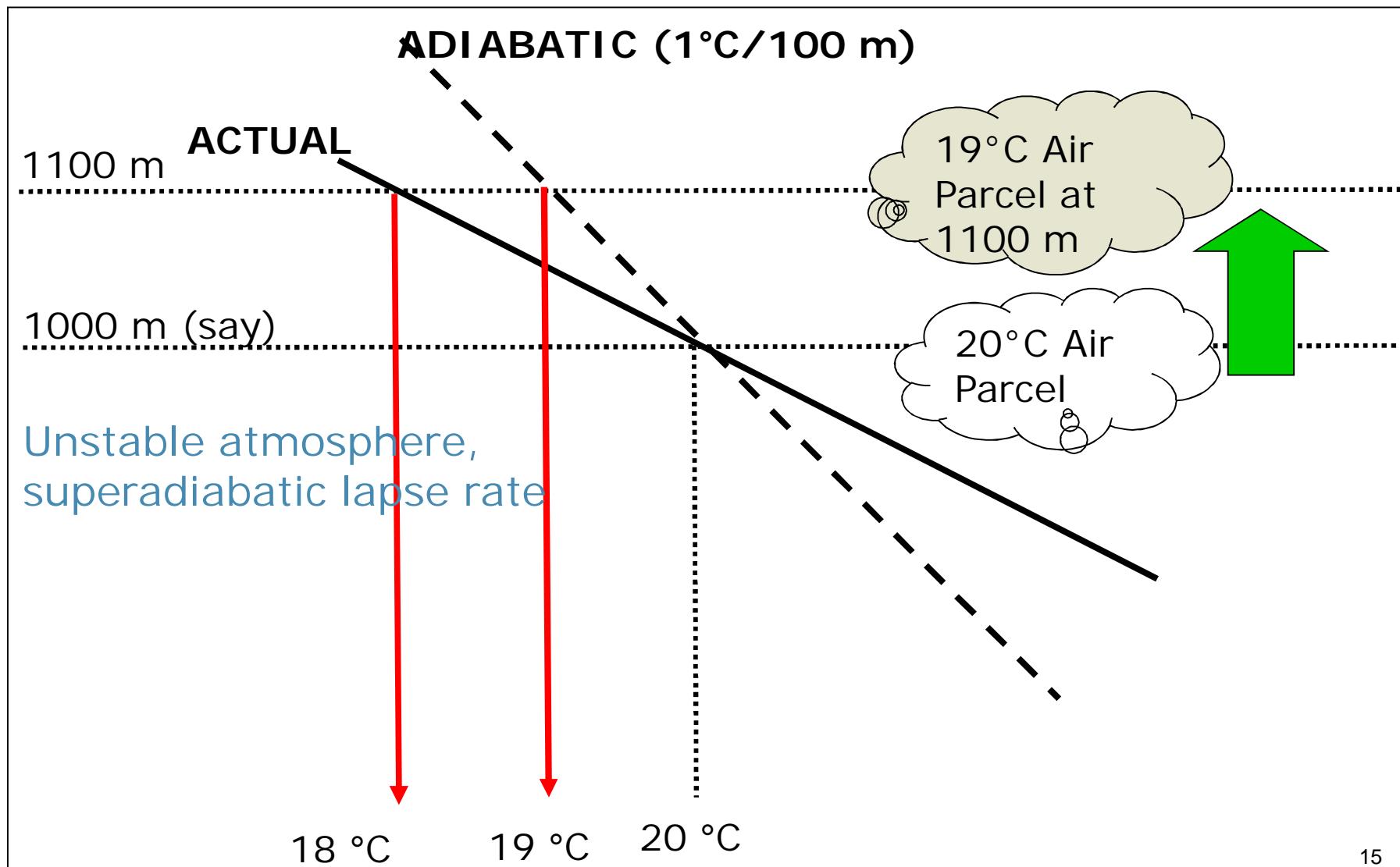
- Dry (Adiabatic) $10^{\circ}\text{C}/\text{km}$
- Wet (Adiabatic) $6^{\circ}\text{C}/\text{km}$
(Release of heat with condensation)

$$\Gamma = -\frac{dT}{dz} = -\frac{g}{C_P} = -1^{\circ}\text{C}/100 \text{ m}$$

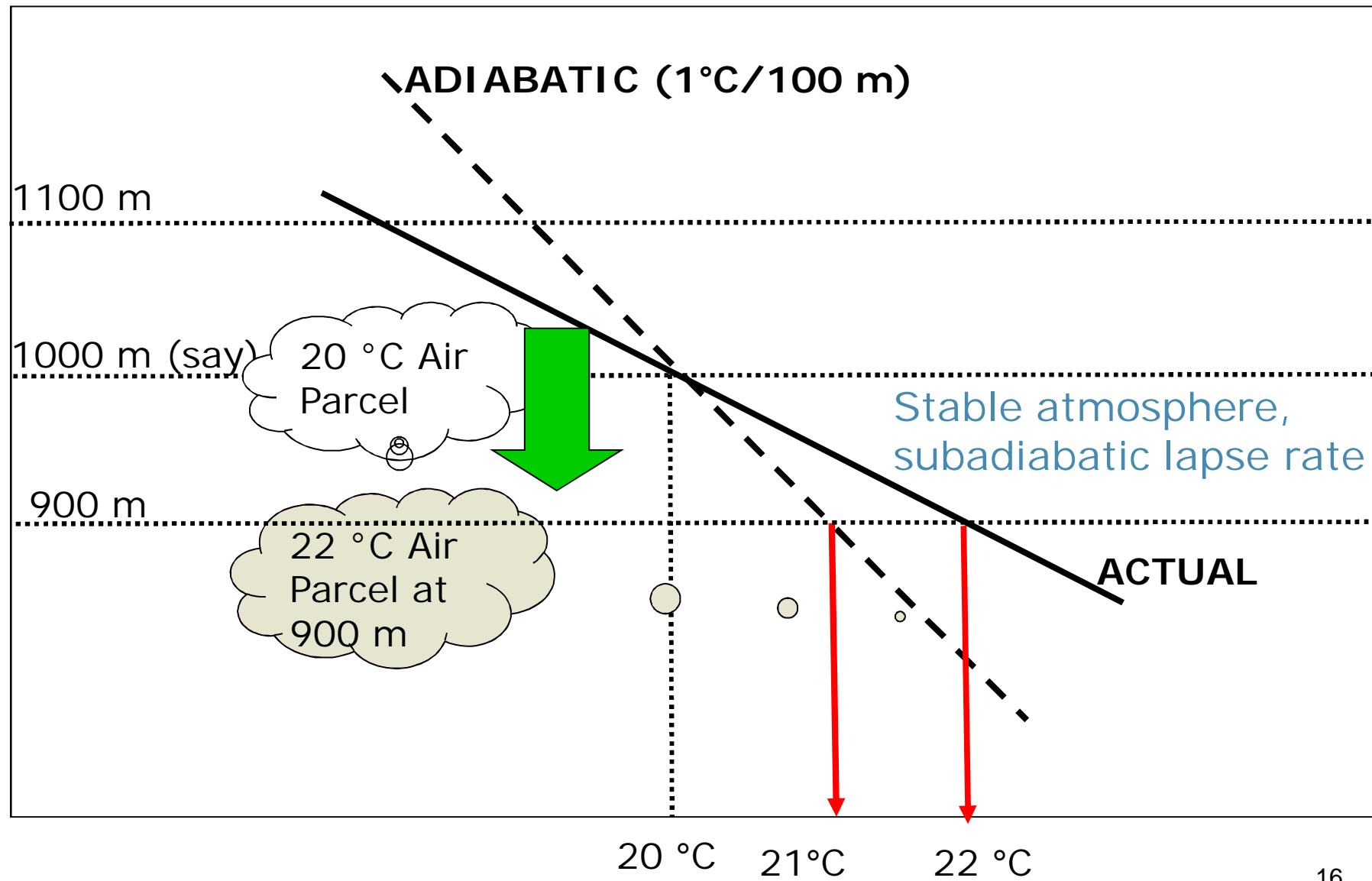
Actual lapse rate

- $< \Gamma$, unstable or super-adiabatic
- $> \Gamma$, stable or sub-adiabatic
- $= \Gamma$, neutral (same rate)

Vertical mixing: Lapse Rates



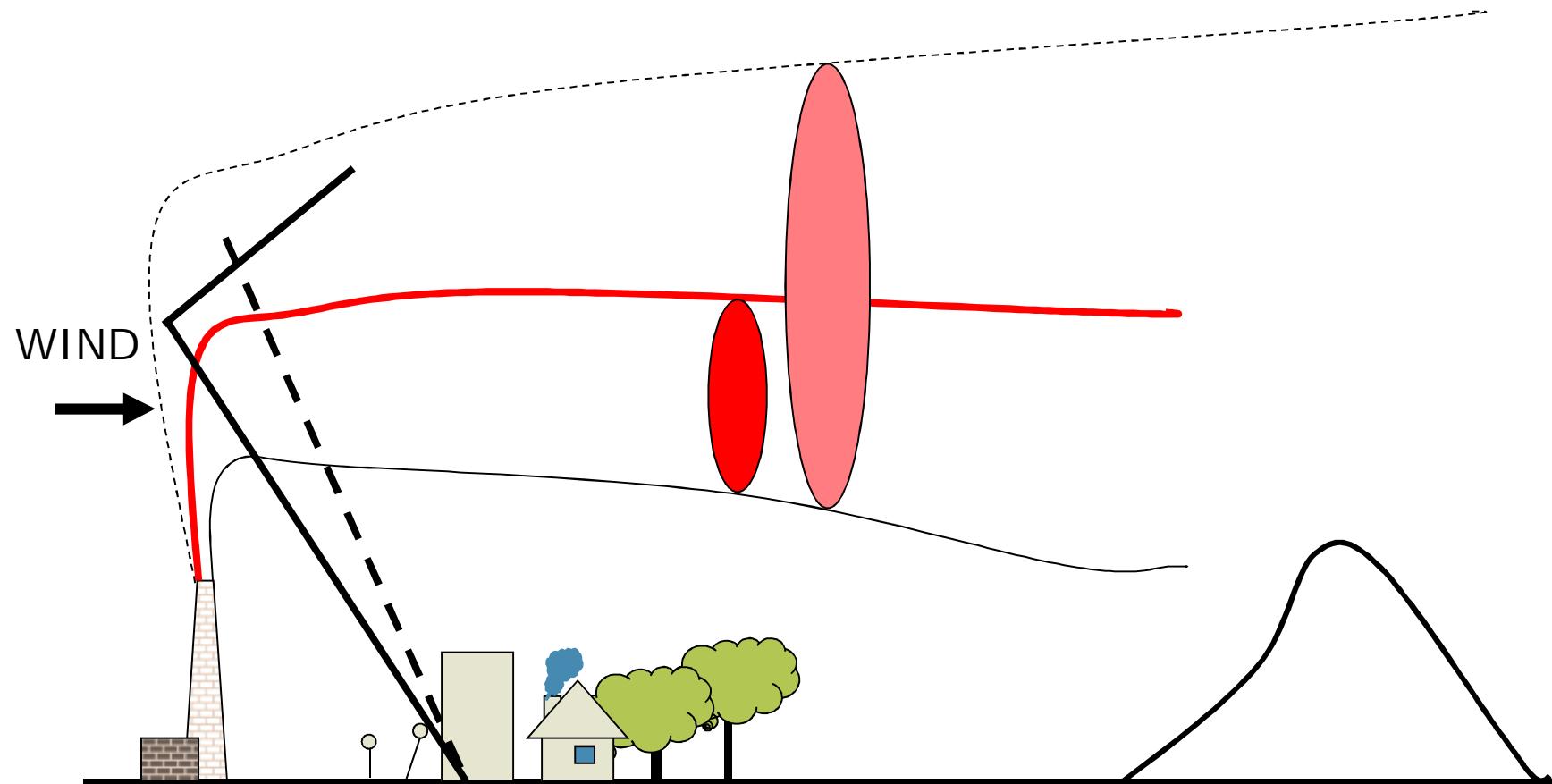
Vertical mixing : Lapse Rates



Lapse rates: Scenarios

--- Adiabatic

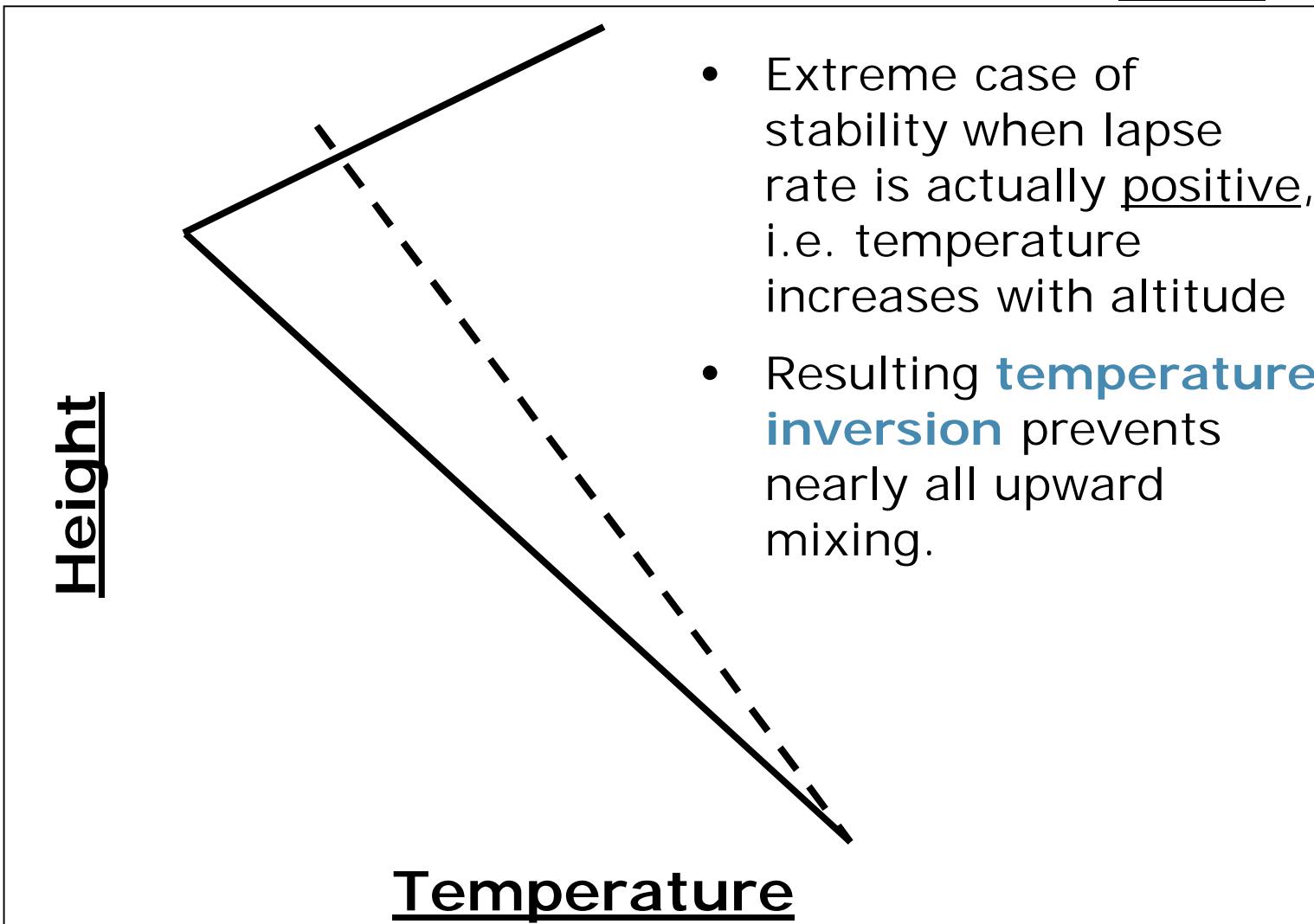
— Actual



Lapse rates: Scenarios

— — — Adiabatic

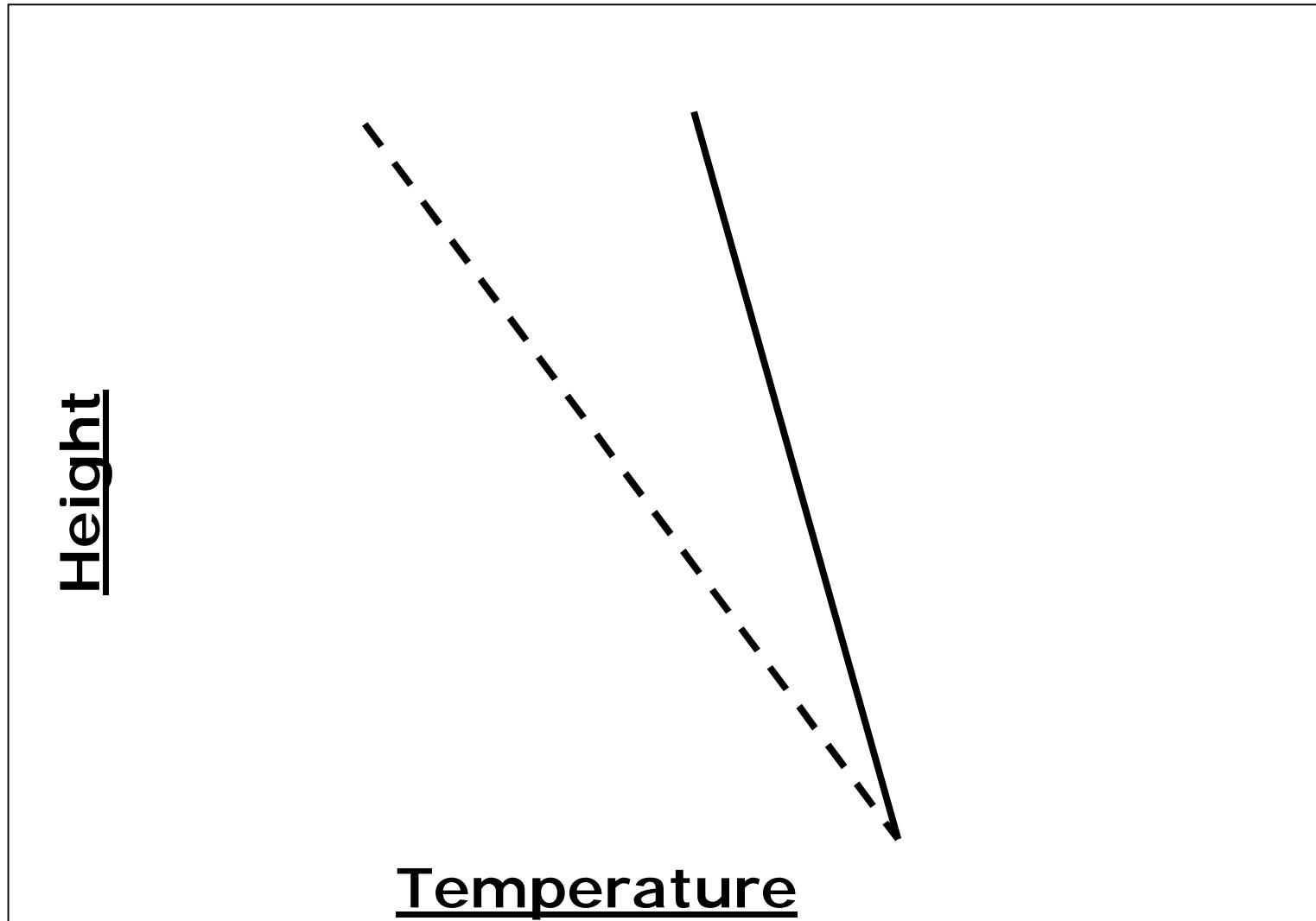
— Actual



Lapse rates: Scenarios

— — — Adiabatic

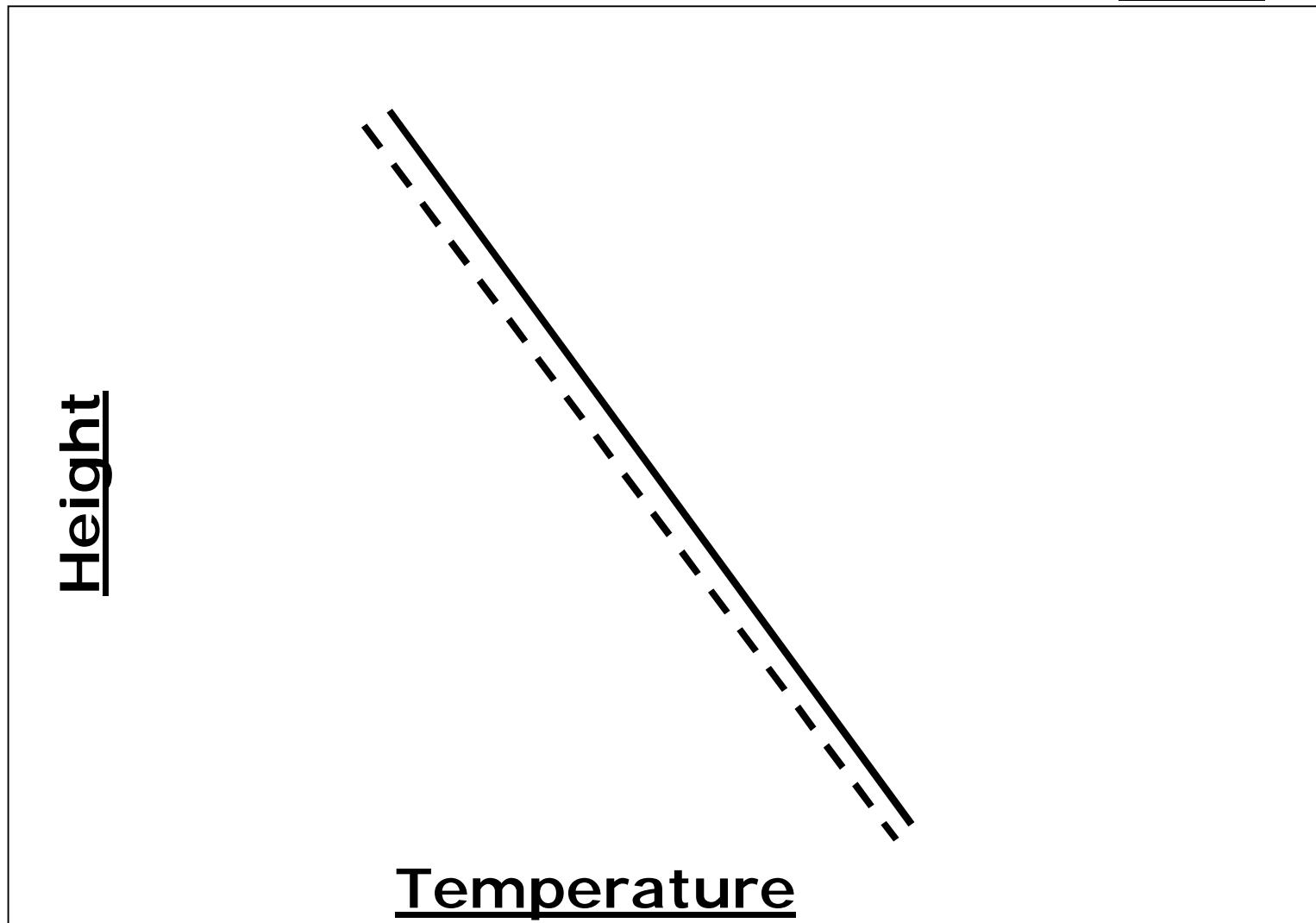
— — Actual



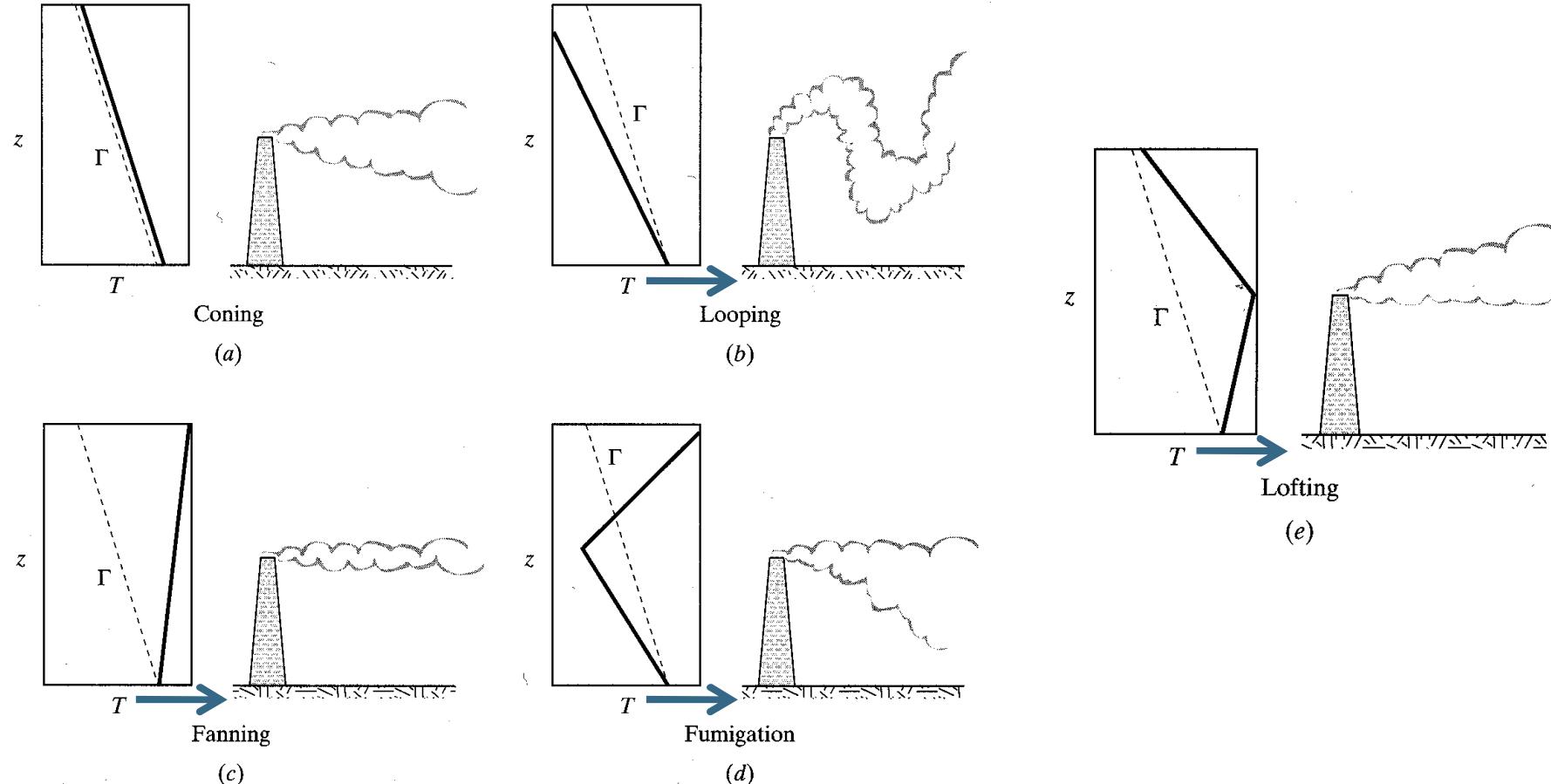
Lapse rates: Scenarios

— — — Adiabatic

— — Actual



Effect of Lapse Rate on Plumes



Masters & Ela, 2008

Time now for the ...

Quiz !!!