

Air Pollution

Lecture 14

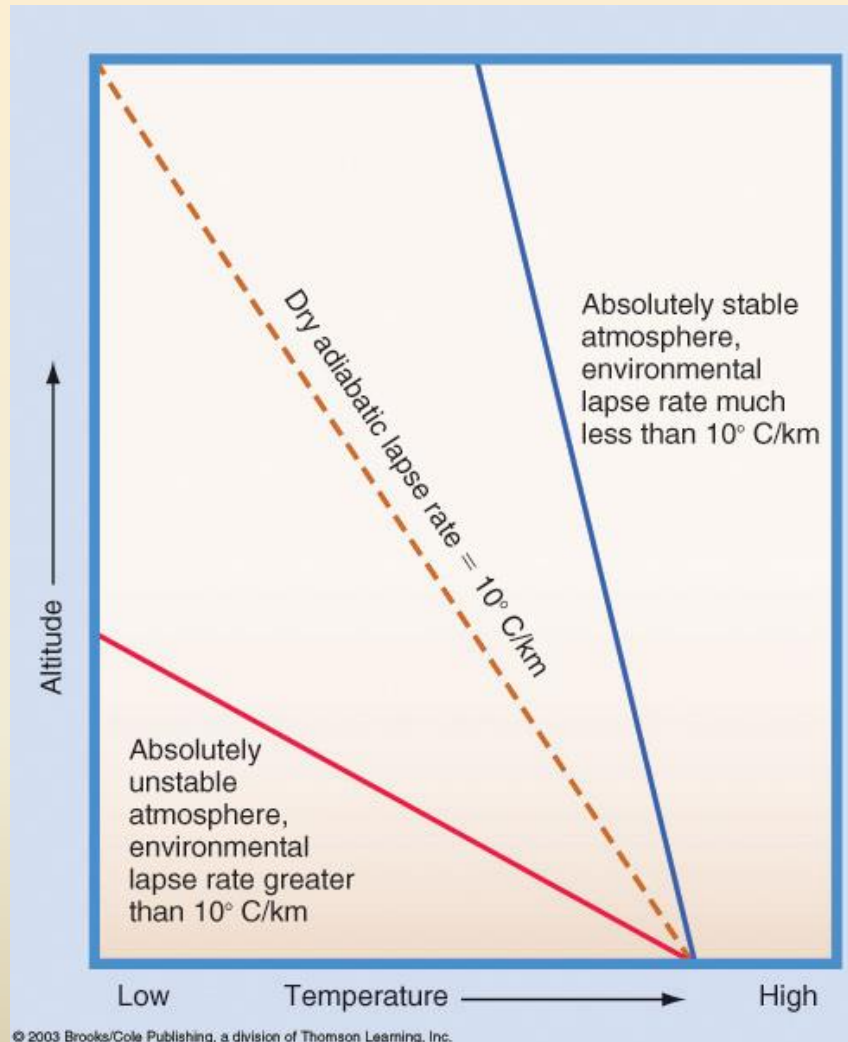
Sahraei

Physics Department

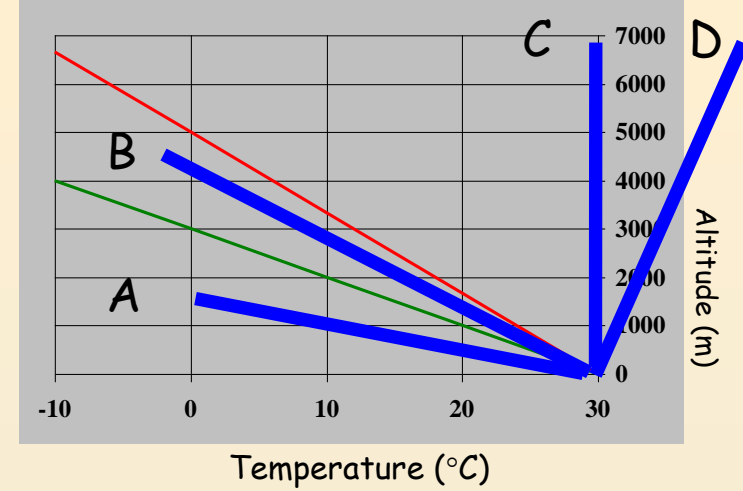
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Lapse rates and stability



Types of Stability



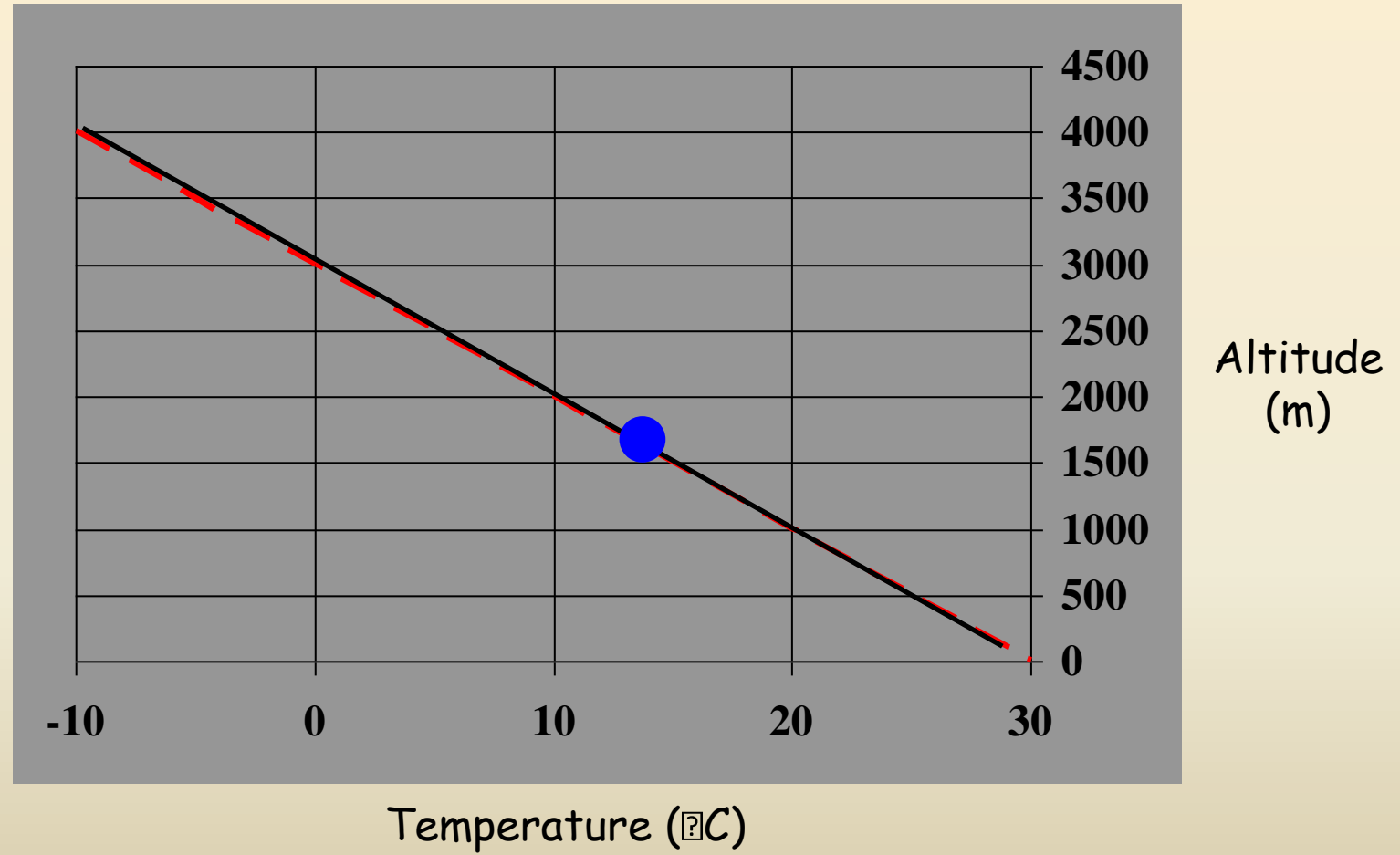
<u>Sounding</u>	<u>Unsaturated</u>	<u>Saturated</u>	<u>Category</u>
A	Unstable	Unstable	Absolute Instability
B	Stable	Unstable	Conditional Instability
C	Stable	Stable	Absolutely Stable -- Isothermal
D	Stable	Stable	Absolutely Stable -- Inversion

(Dry) Neutral Atmosphere

Dry Adiabatic
Lapse Rate

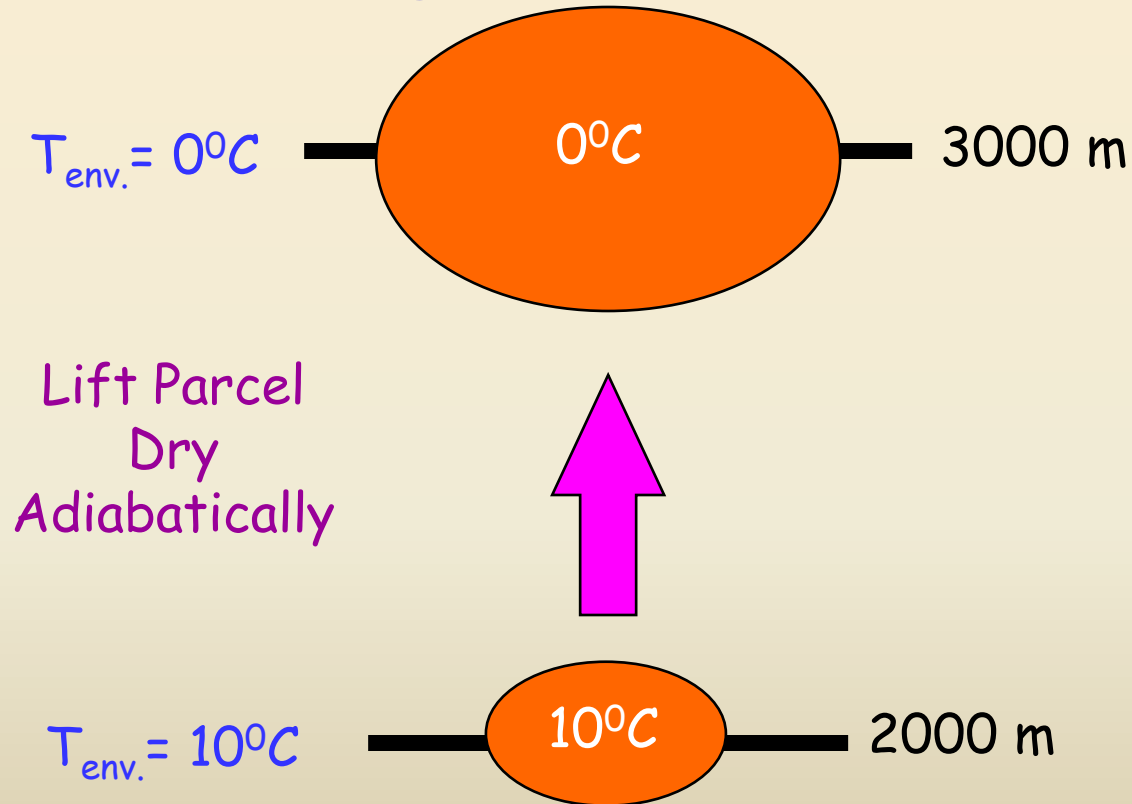
Environmental
Sounding

● Parcel



(Dry) Neutrally Stable Atmosphere

Since the parcel temperature is the same as the environment the parcel will neither continue to move away from nor return to its original level.



Compare Lifted Parcel Temperature to the Environmental Temperature

Neutral Stability

Dry Neutral

Environmental lapse rate equals the dry adiabatic lapse rate.

Can result from thoroughly mixing air.

Moist Neutral

Environmental lapse rate equals the moist adiabatic lapse rate.

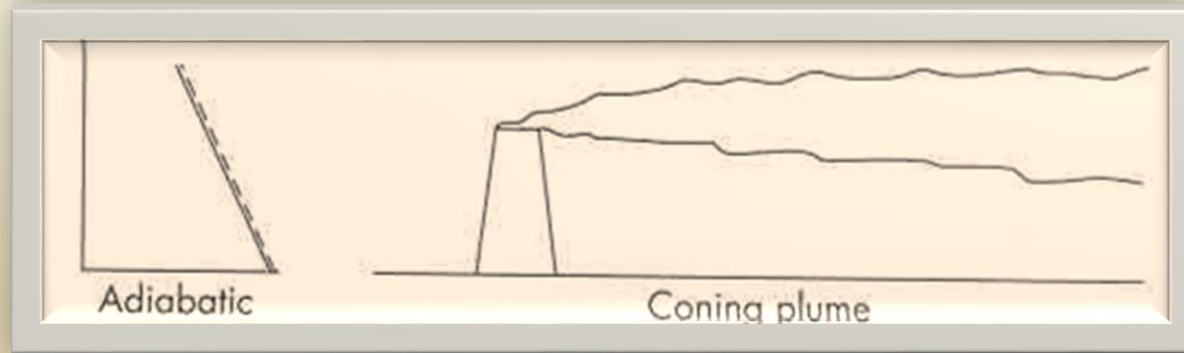
Effect of atmospheric Stability on plume Dispersion

The dispersion of air pollutants is primarily determined by atmospheric conditions.

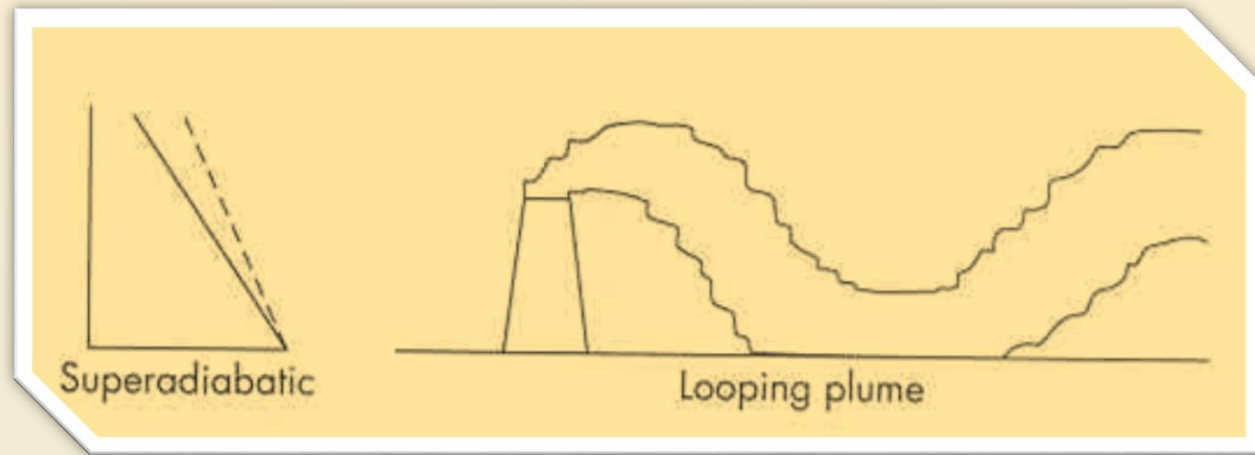
تقسیم بندی و چگونگی توسعه ستونهای دود

اثر دیگر هواشناسی محلی بر آلودگی هوا اثر پایداری انتشار ستون دود از دودکش ها است.

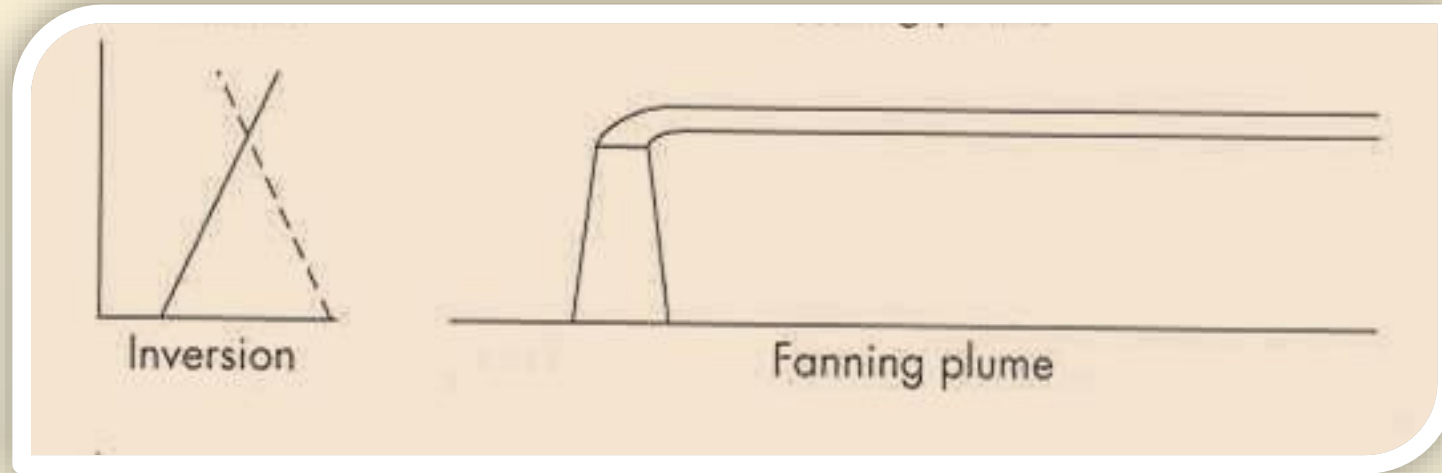
اگر دود خروجی از دودکش یک کارخانه در شرایط پایداری خنثی وارد هوا شود و جبهه دود به صورت متقارن توسعه خواهد یافت که اصطلاحاً آنرا توسعه مخروطی یا قیفی می نامند.



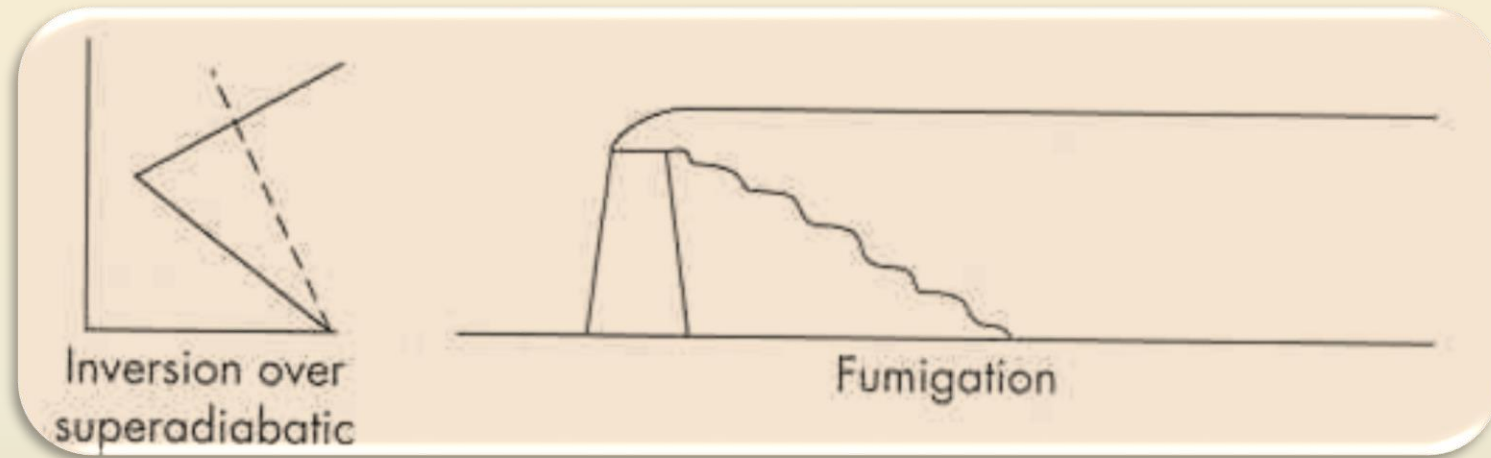
در صورتی که شرایط جوی بسیار ناپایدار باشد حرکات عمودی توده های هوا به بالا و پائین باعث توسعه حلقوی جبهه دود می شود.



در شرایطی که هوا بسیار پایدار باشد از پراکنده شدن مواد آلاینده (جبهه دود) به صورت عمودی جلوگیری می شود و در این حالت جبهه دود بطور افقی حرکت خواهد کرد که نتیجه آن توسعه بادبزی این جبهه خواهد شد.

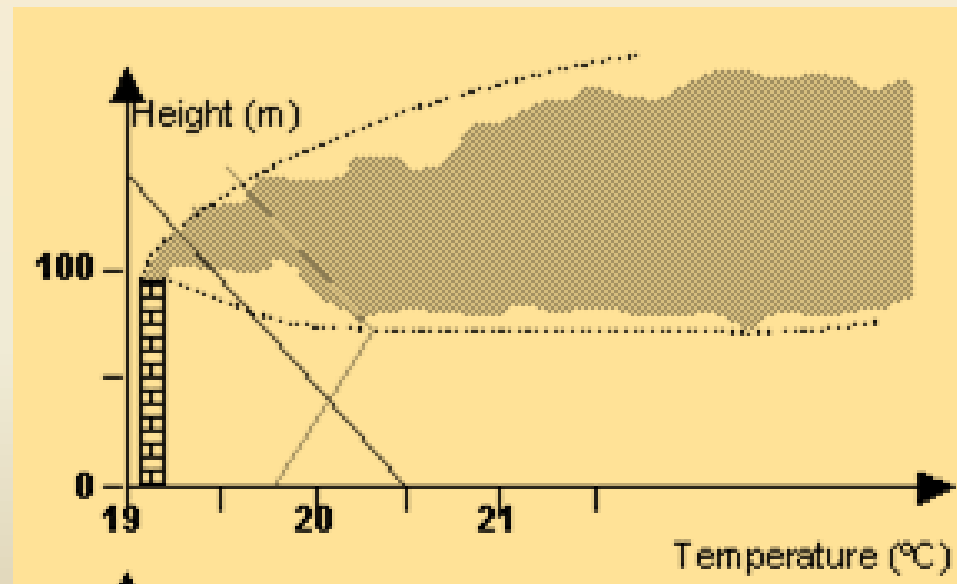


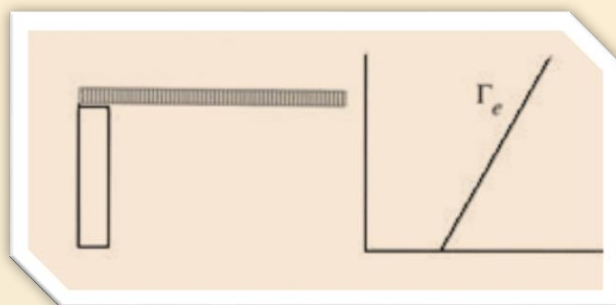
در صورتی که وارونگی هوا بر جو حاکم باشد جبهه دود پس از کمی صعود به سمت پایین رانده می شود که در این حالت به آن **توسعه دودی** می گویند در این حالت با افزایش سرعت باد به سمت سطح زمین غلظت مواد آلاینده در سطح افزایش می یابد.



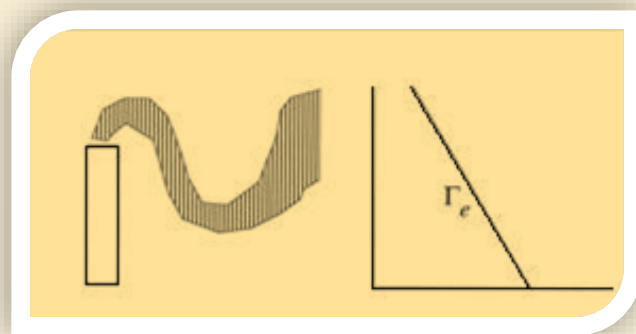
هنگامی که جبهه دود بالاتر از لایه وارونه قرار گرفته است آمیختگی به سمت بالا بدون هیچ محدودیتی انجام می گیرد و در این حالت از حرکت رو به پایین جبهه دود به شدت جلوگیری می شود.

بروز چنین حالتی که به آن توسعه بالا رونده گفته می شود در دور کردن مواد آلاینده از سطح زمین بسیار مفید است.

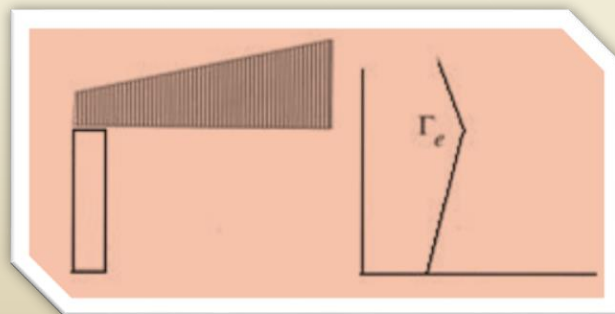




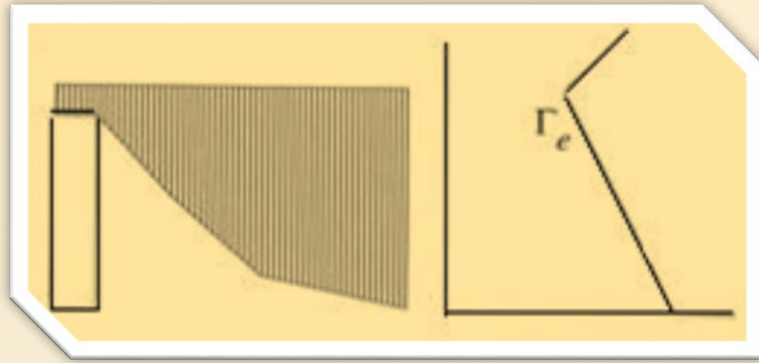
انتشار بادبزنی، پایداری، وضعیت وارونگی



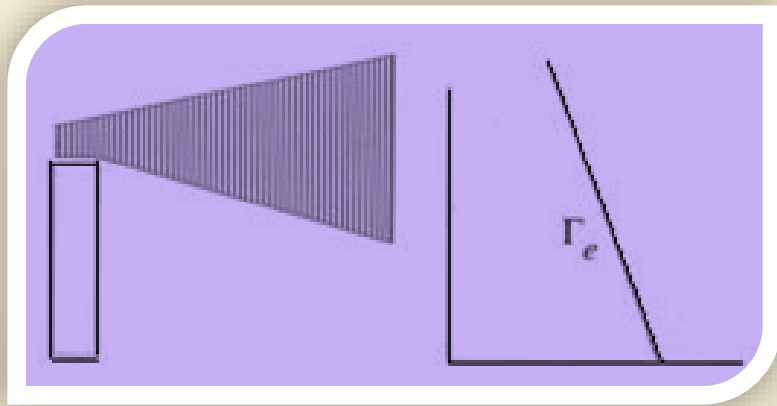
انتشار حلقوی، ناپایداری، سرد شدن شدید



انتشار بالارونده، پایداری در سطوح
پایین (وارونگی)، خنثی در سطوح بالا

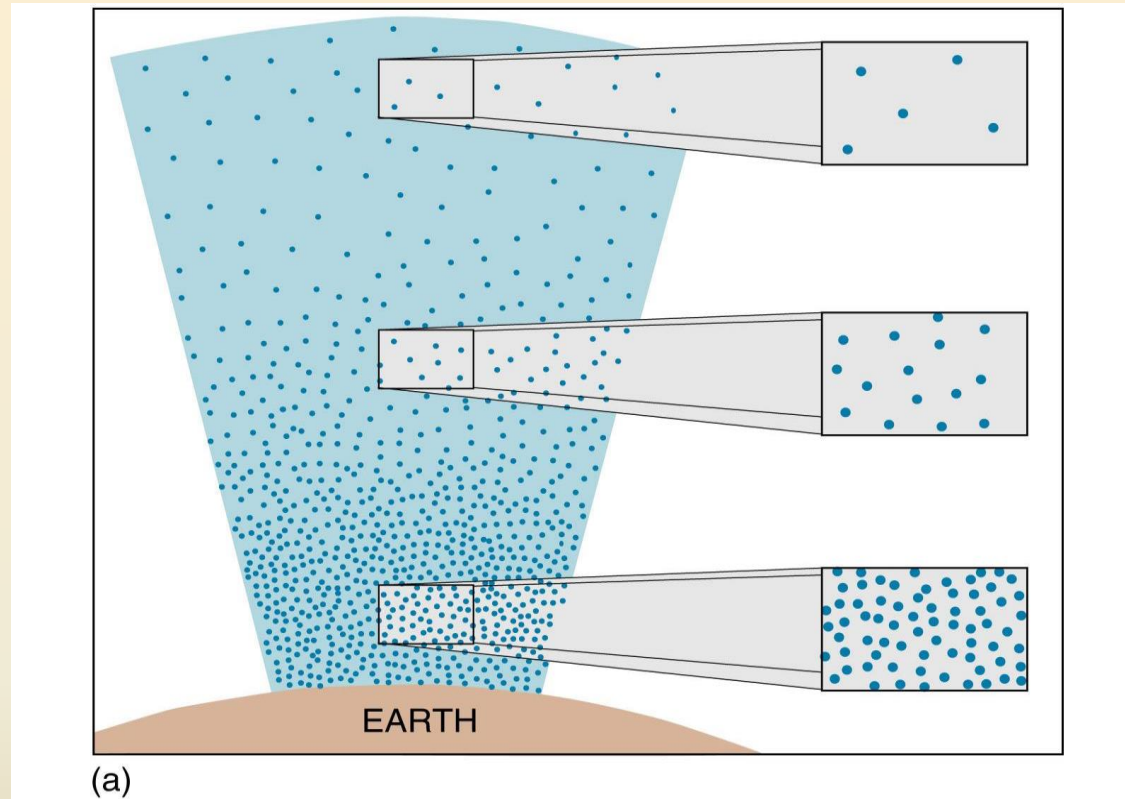


انتشار دودی، خنثی یا ناپایداری در سطوح
پایین دود کش، پایداری (وارونگی) در سطوح بالا



انتشار مخروطی، خنثی، سرد شدن ضعیف

Air Molecule Density

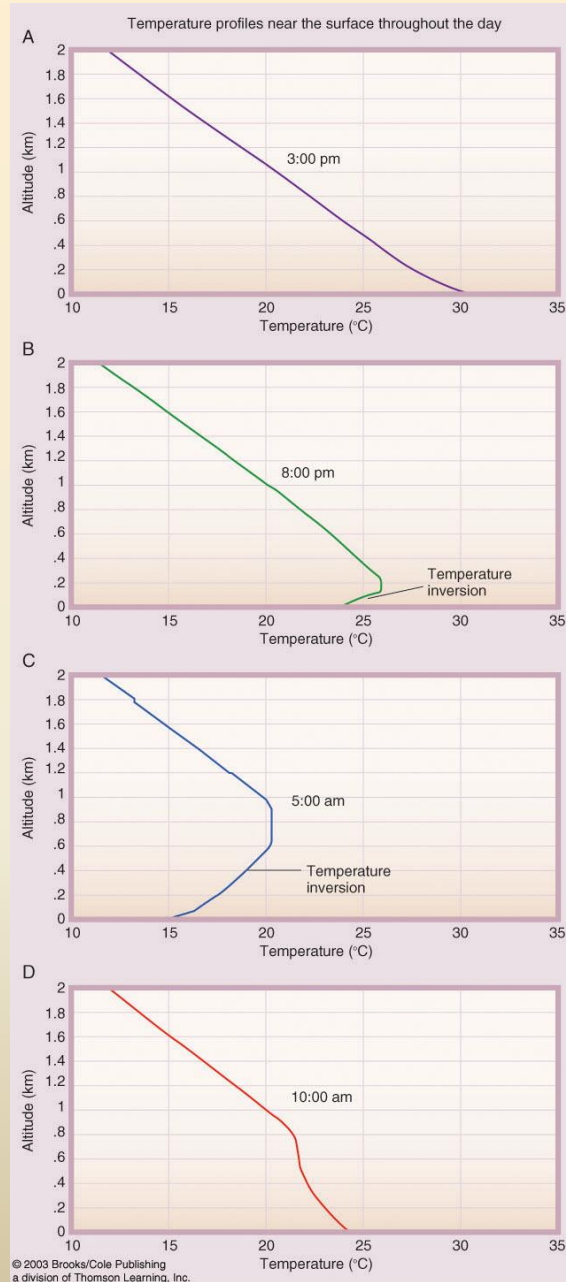


As you go higher in the atmosphere, air becomes less dense.

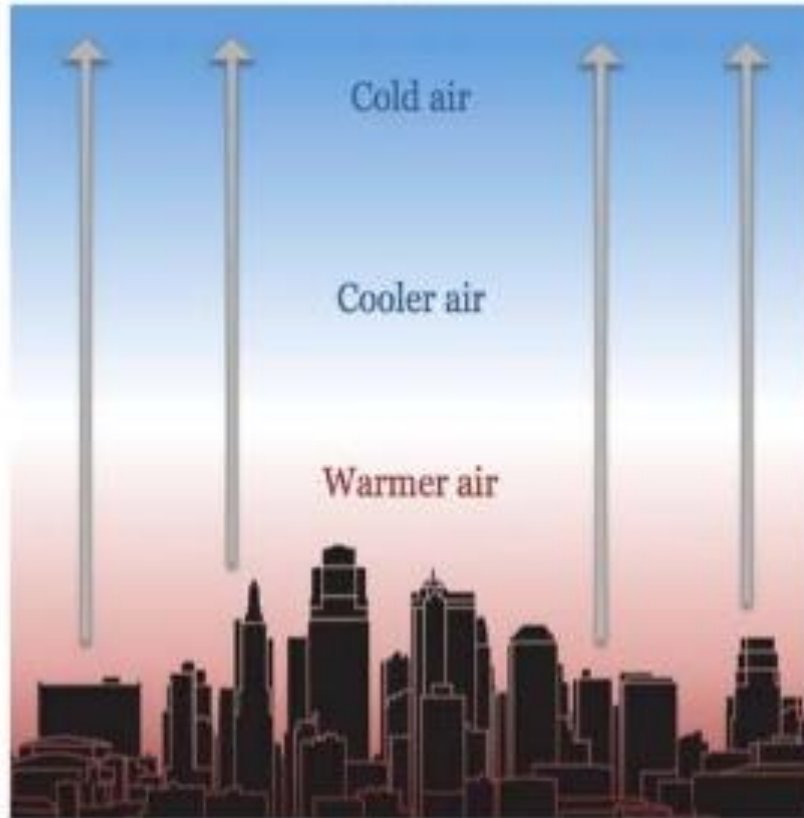
Smoke Rises in the Air,
Normally



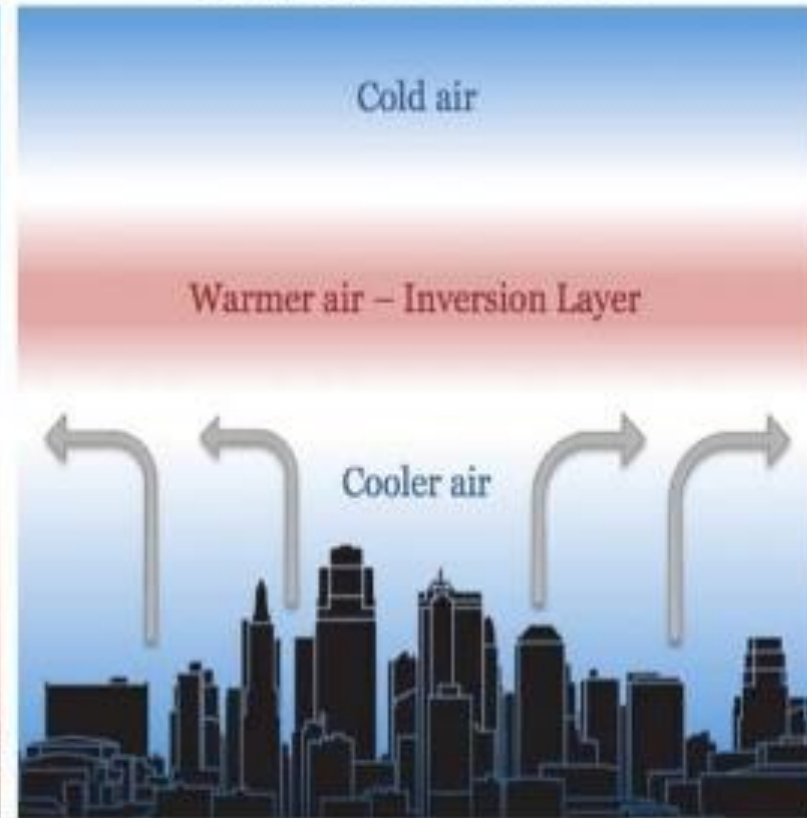
Temperature inversion



Normal Conditions

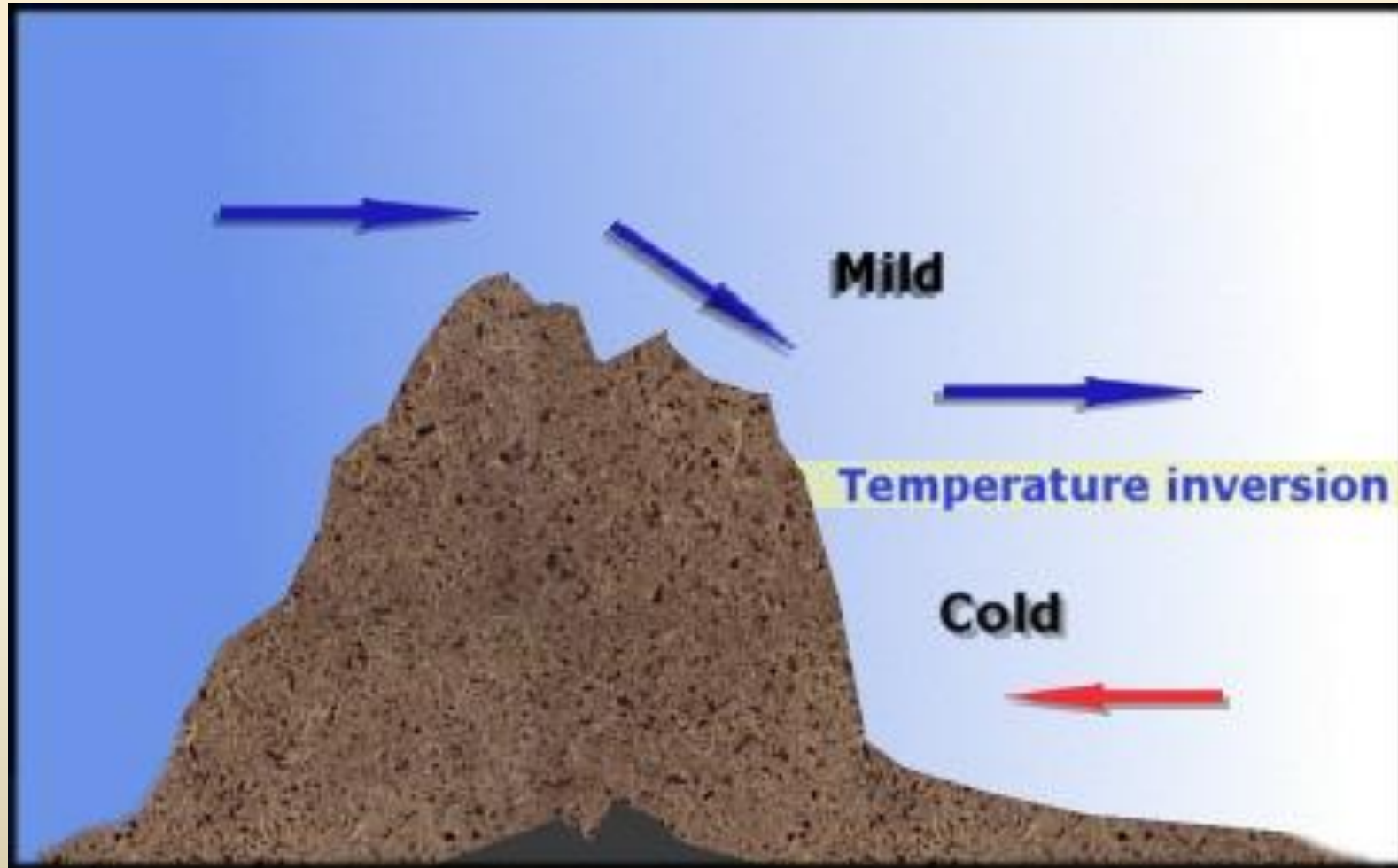


Temperature Inversion

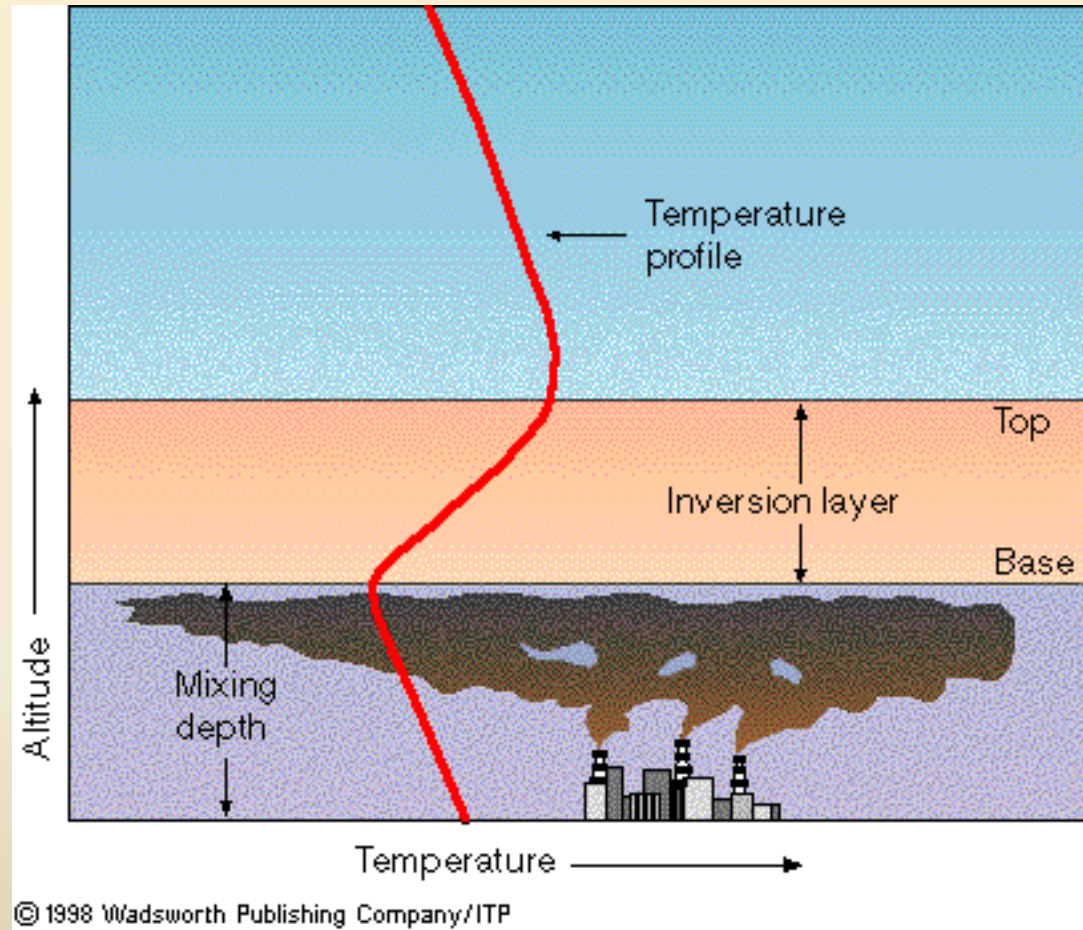


Arrows show air flow in normal conditions on the left and during temperature inversion on the right. In normal conditions, warm air rises and normal convective patterns persist. During temperature inversion, the warm air acts as a cap, effectively shutting down convection and trapping smog over the city.

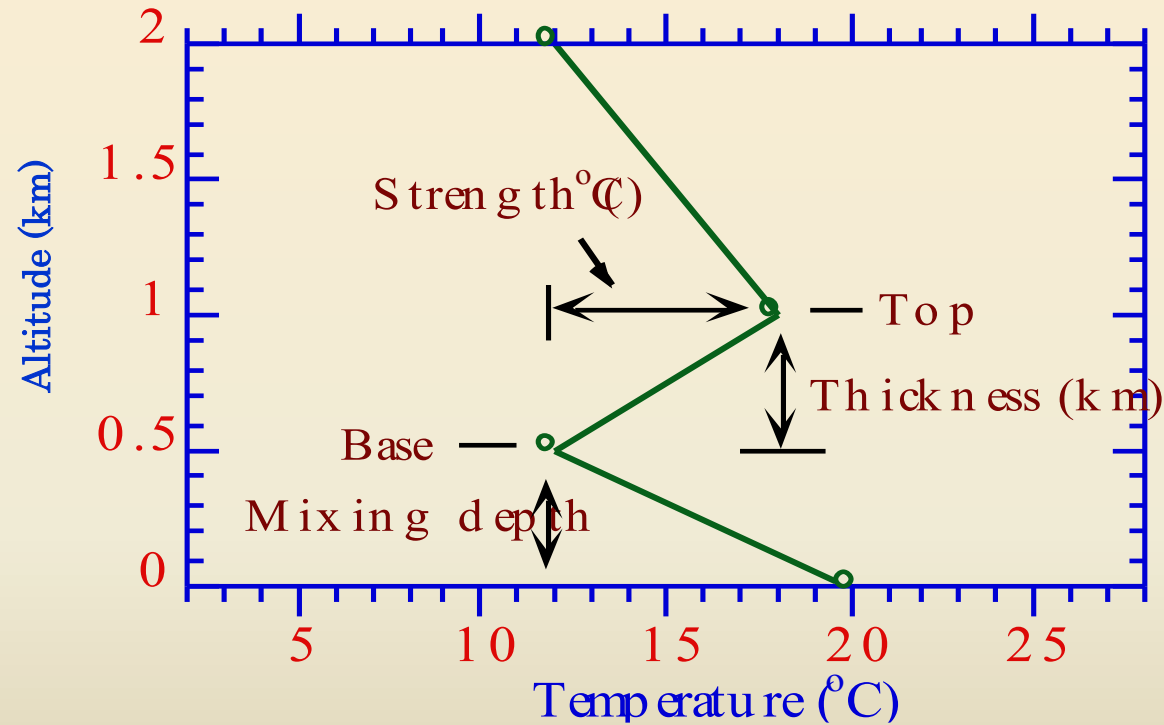
How inversion Happens



Inversion



An inversion is characterized by its strength, thickness, top/base height, and top/base temperatures.

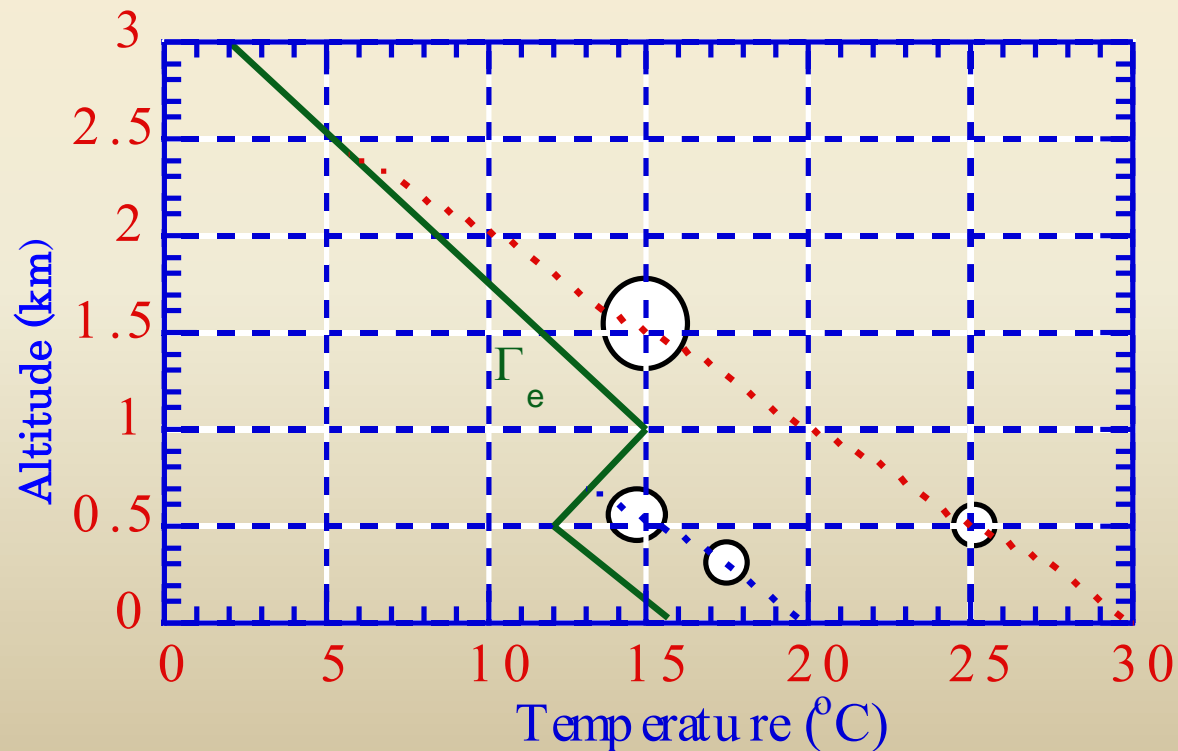


Lapse Rate

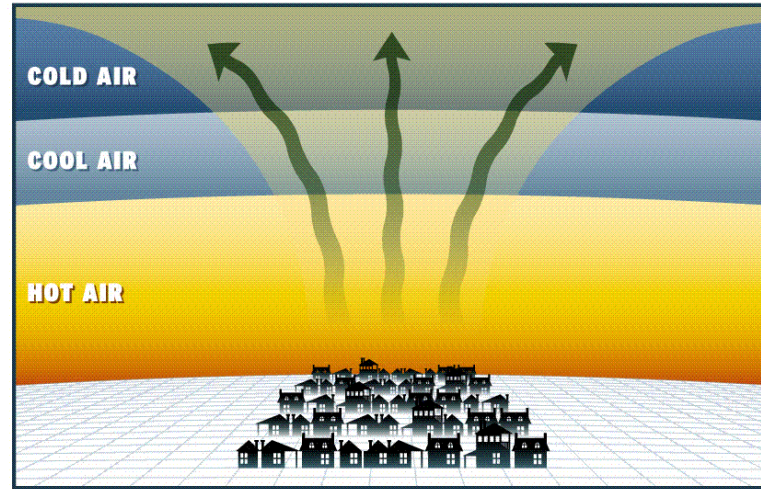
The rate at which air temperature decreases with height.

The standard (average) lapse rate in the lower atmosphere is about 6.5°C per 1 km.

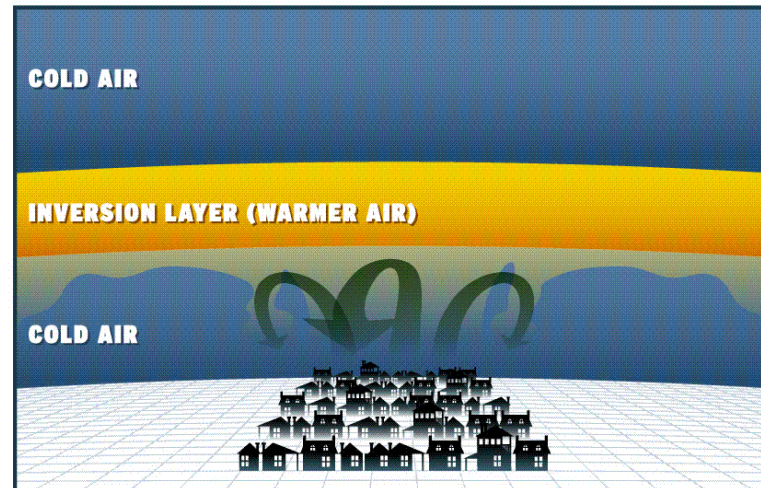
Trapping Pollutants Under an Inversion



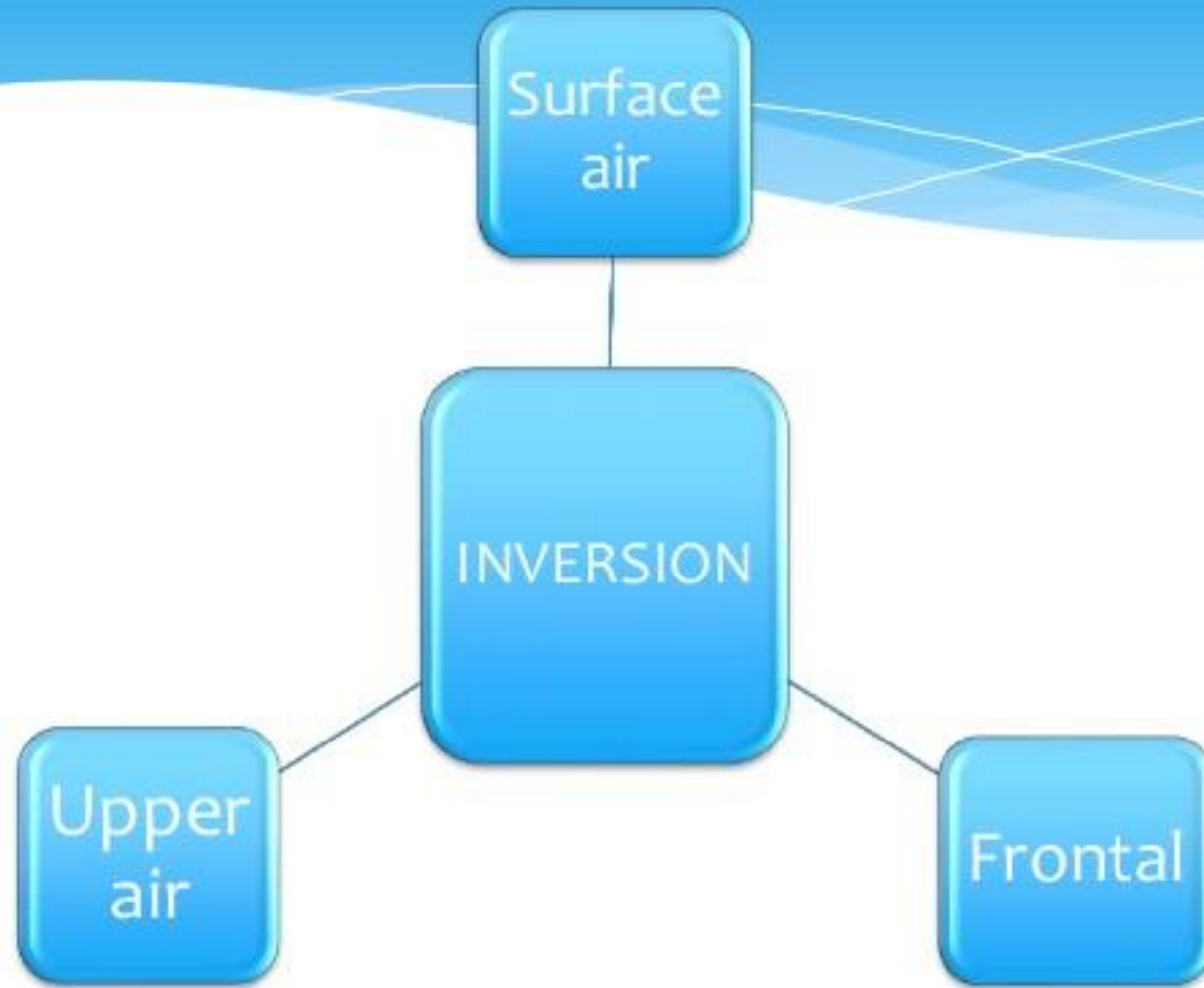
NORMAL SITUATION



TEMPERATURE INVERSION



TYPES OF TEMPERATURE INVERSIONS



Inversions form whenever a layer of air becomes colder than the layer of air above it.

Common inversion types include :

the radiation inversion

the large-scale subsidence inversion

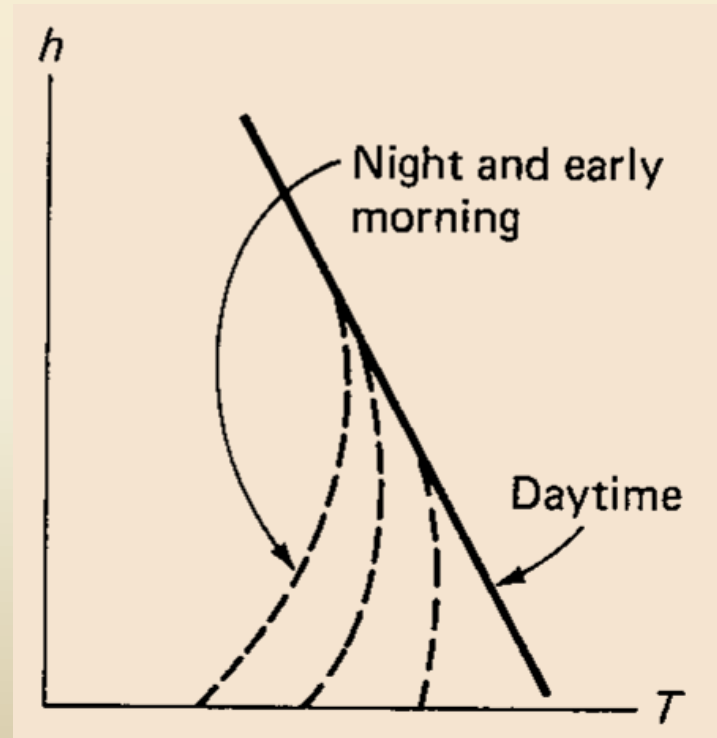
the marine inversion

the frontal inversion

small-scale subsidence inversion

The radiation inversion,

radiation at night from the earth's surface into the local atmosphere



Radiational Inversions

- Result from radiational cooling of the ground
- Occur on cloudless nights - nocturnal
- Typically surface based
- Are intensified in river valleys
- Cause pollutants to be "trapped"

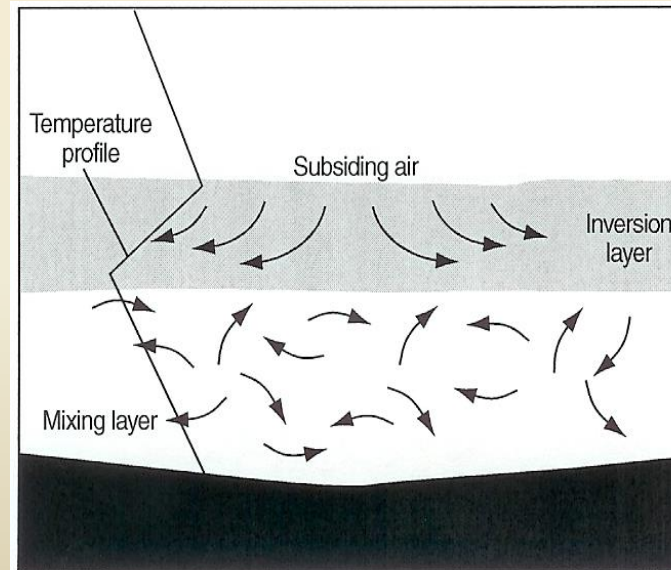
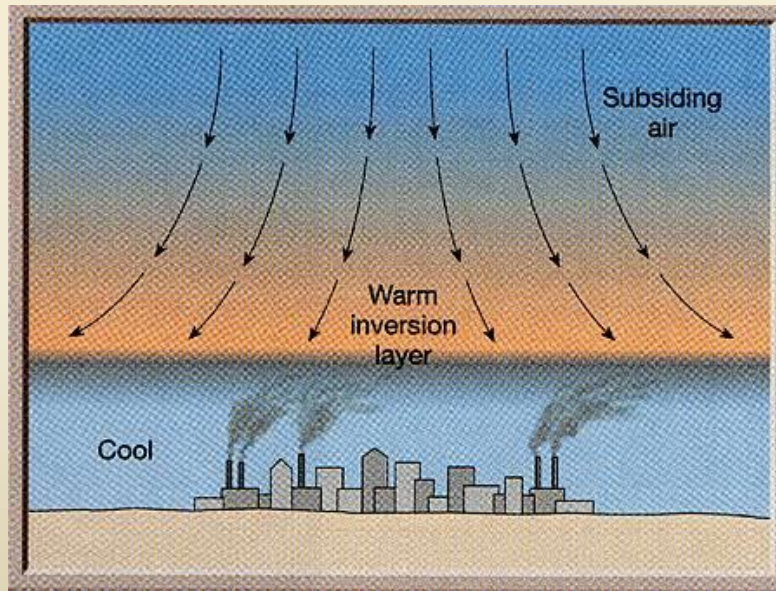
Radiational Inversions

- ✱ Breakup after sunrise
- ✱ Breakup results in elevated ground level concentrations
- ✱ Breakup described as a fumigation



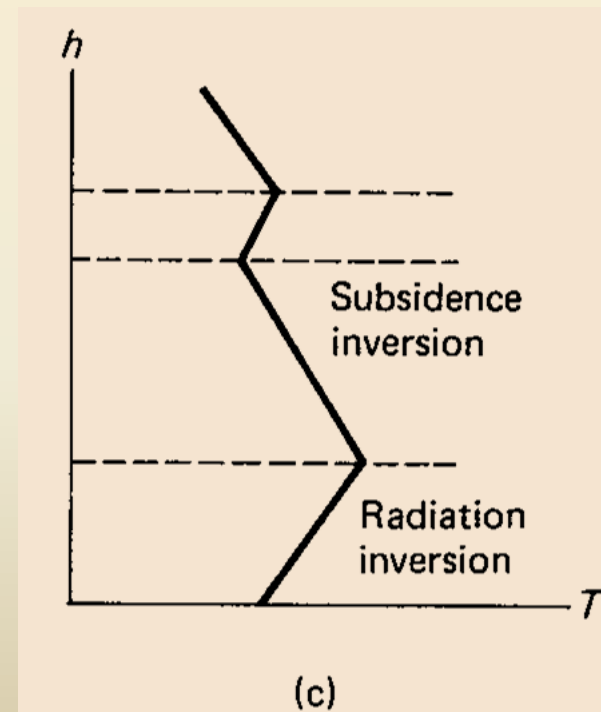
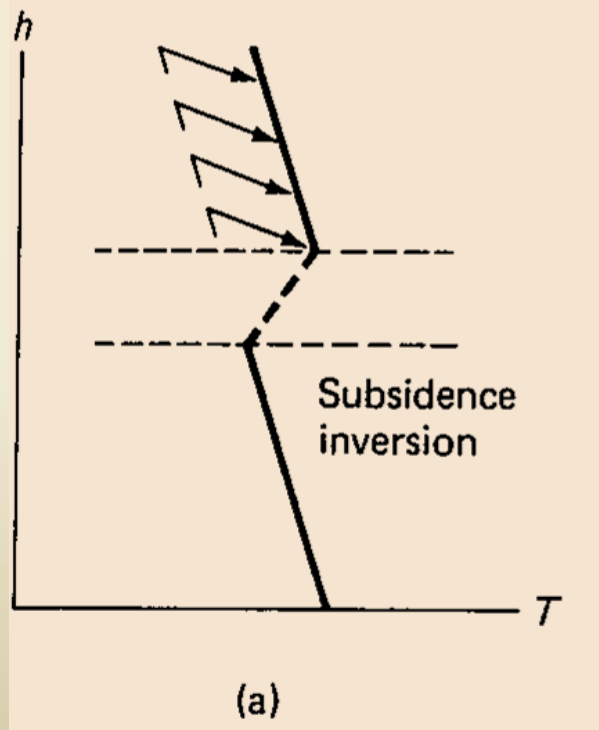
Subsidence Inversion

- Associated with high-pressure systems
- Inversion layer is formed aloft
- Covers hundreds of thousands of square kms
- Persists for days



Large-Scale Subsidence Inversion

descent of a layer of air with in a high pressure air mass



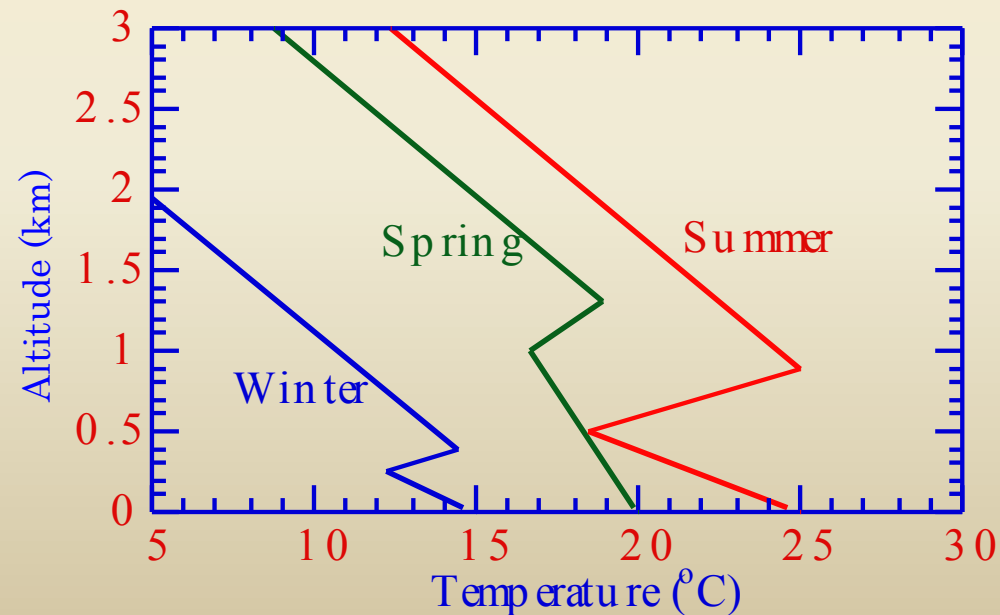


Seasonal Variation of Inversions

Figure illustrates the seasonal variation of afternoon inversion profiles in Los Angeles.

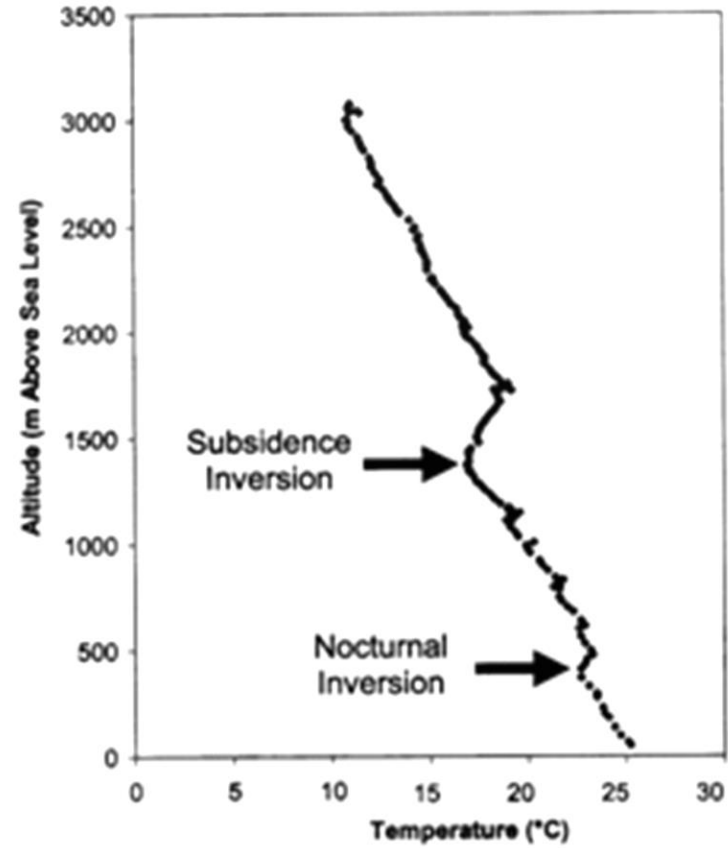
During the winter, the Pacific high is further from Los Angeles than it is during any other season, and the large-scale subsidence inversion strength is weak.

During the summer, the inversion is strong because the center of the Pacific high is closer to Los Angeles than it is during any other season.



Fort Meade profile 6/19/2001

Fort Meade Profile 9:06-9:35 EDT 6/19/2001



Frontal - warm air overrides cooler air

Advection Inversion



Cool air flows
underneath warm air

• In Southern California,
called the "Marine Layer"

