Unconditionally unstable layers (also known as "absolutely" unstable layers):

- $|ELR| > |DALR|$ $\quad \frac{\Delta T}{\Delta z} < -g/c_p$ (DALR)

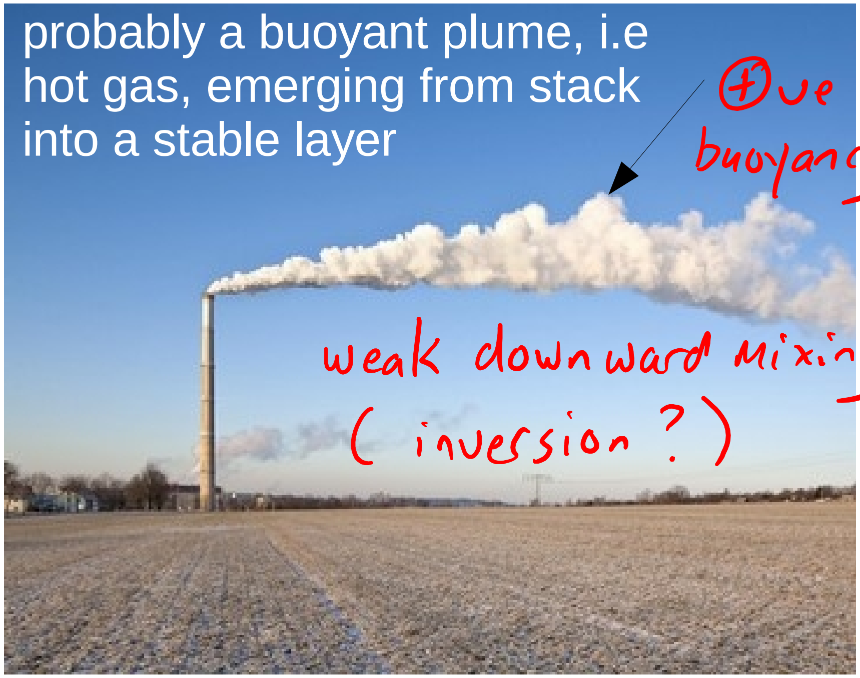
Seldom occur aloft, but are normal in the summer daytime ASL (Atmos. surface layer), lowest ~ 50 - 100 m.
Unstable buoyancy forces, strong turbulence and mixing.

Unconditionally stable layers:

- ELR weaker than SALR $\quad \frac{\Delta T}{\Delta z} > \frac{-0.4\text{ K}}{100\text{ m}}$ (MALR)
- common at all elevations
- strongest case is the “inversion,” in which ELR is positive (temperature increasing with z)
- buoyancy forces suppress mixing

Neutrally stable layers:

- ELR equals DALR (if unsaturated) or SALR (if saturated)
- common
- brought about by strong mixing and/or absence of heat input/loss
- strong winds and overcast skies tend to produce neutrally-stratified layer



Conditionally unstable layers: $T_d < T < T_m$

- ELR between DALR and SALR $\left(T = \frac{\Delta T}{\Delta z} \right)$

  i.e. between the two benchmarks.

- overall, most common state of the free troposphere (above the ABL)

- less common in high latitude winter (thus deep convection and convective storms less common In winter)

- absolute instability uncommon above the ASL** because its very existence spurs strong mixing that returns the ELR towards the DALR or SALR

A conditionally unstable layer can produce vigorous convection if vertical motion is forced (eg fronts, topography) and parcels reach the LFC

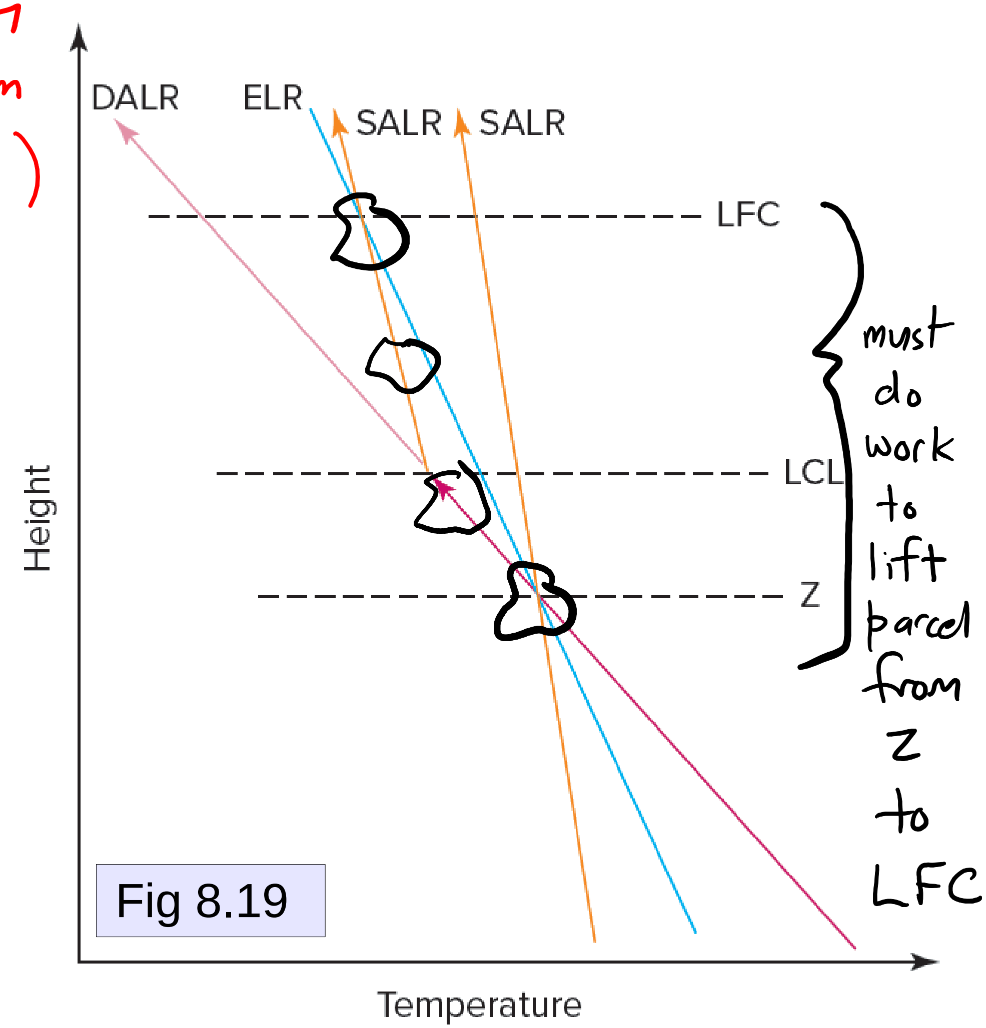


Fig 8.19

Level of Free Convection (LFC) – the level at which an adiabatically lifted parcel first becomes *warmer* than its environment

**Atmospheric Surface Layer (ASL): roughly the lowest 50-100 m of the atmosphere

This is a typical summer fairweather daytime scenario

superadiabatic sfc lyr (uncon. unstab) $\frac{\Delta\theta}{\Delta z} < 0$

neutral in mixed layer $\Delta\theta/\Delta z = 0$

absol. stable above mixed layer $\Delta\theta/\Delta z > 0$

Does Fig 8.21 give sufficient information to determine the LCL, and whether there will be cloud?

NO

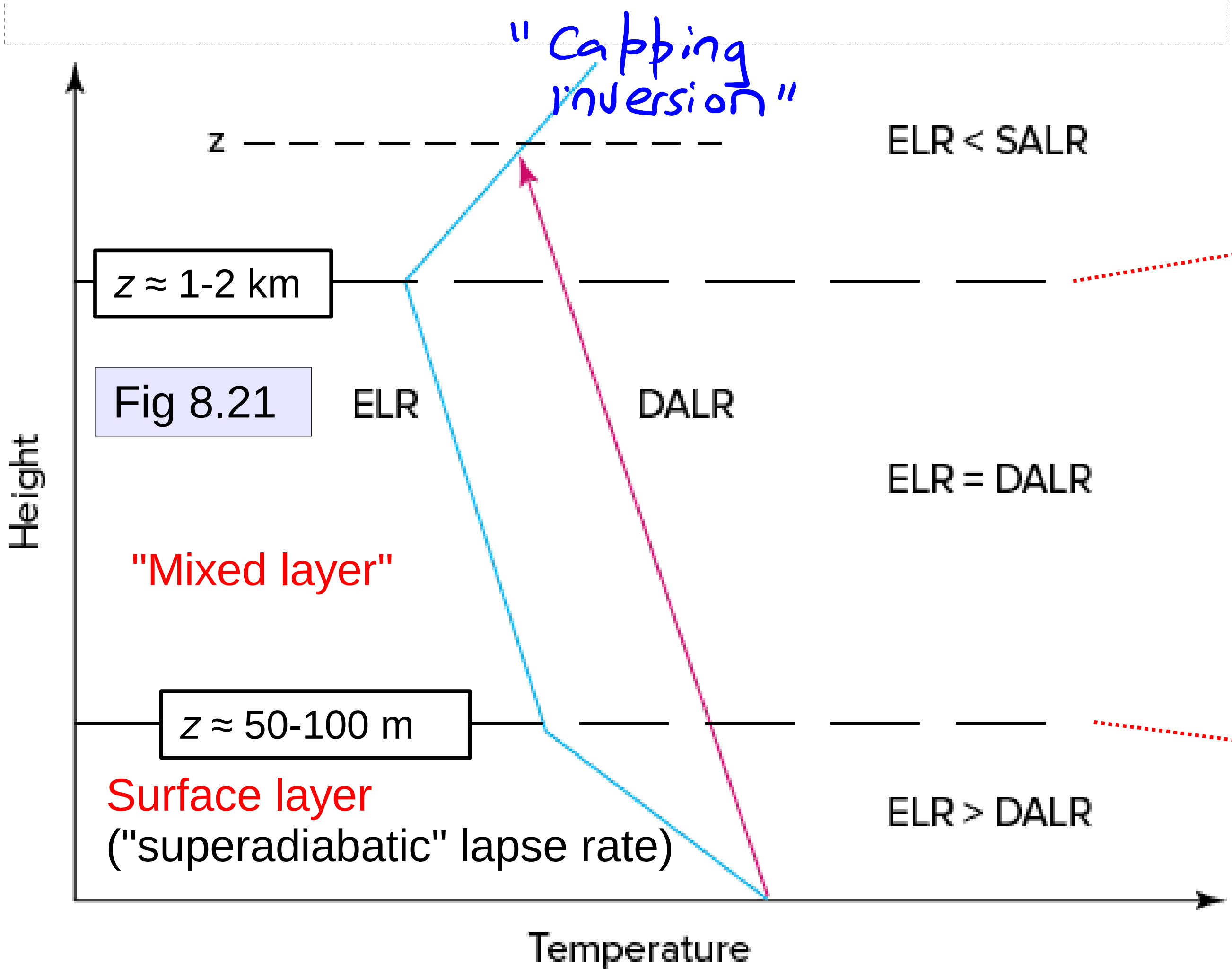


Fig 8.21

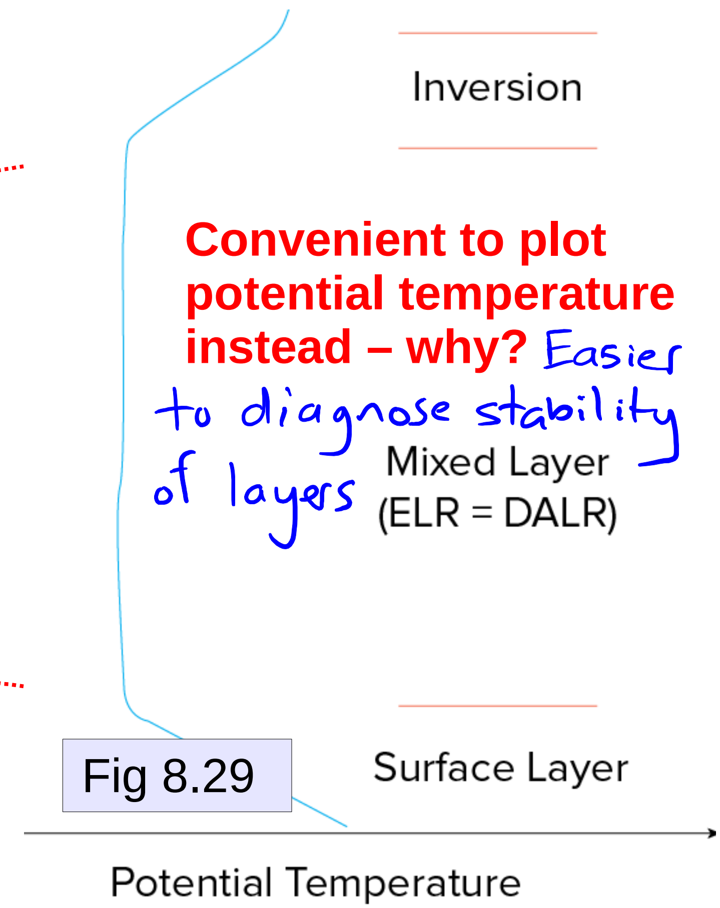


Fig 8.29

Convenient to plot potential temperature instead – why? Easier to diagnose stability of layers

Heating at low levels** **and/or** **Cooling aloft****

$Q_H = K^* + L^* - Q_E - Q_G$ strongly positive during strong solar radiation

Advection of the airmass over a warmer surface

cold advection aloft

longwave radiative cooling of cloud tops

Unstable thermal stratification results in strong mixing, thus efficient transport away from the surface

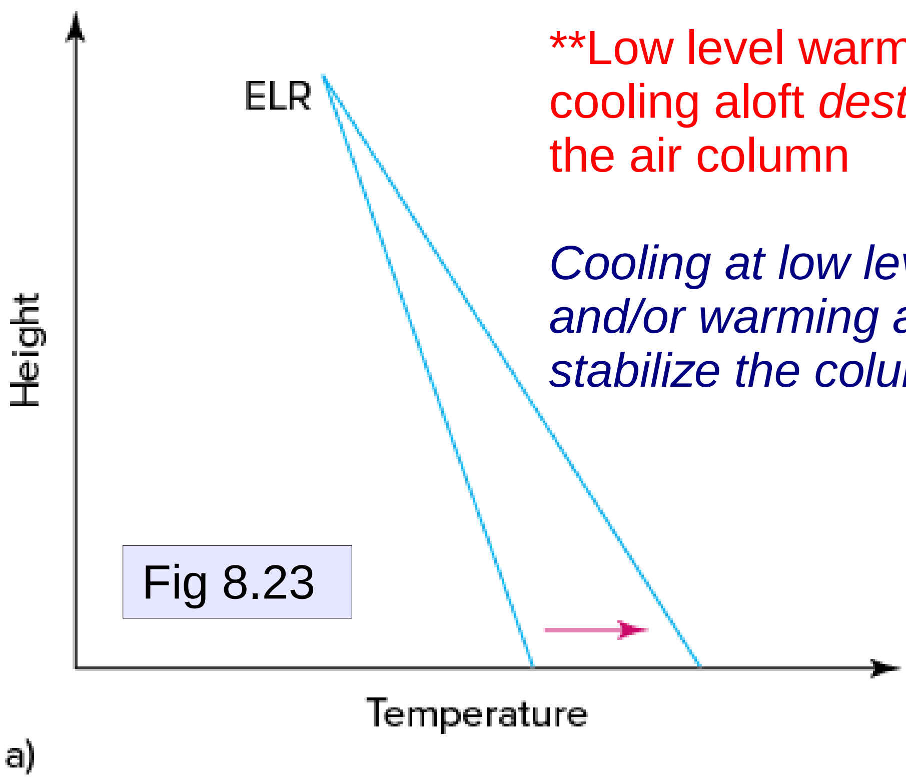
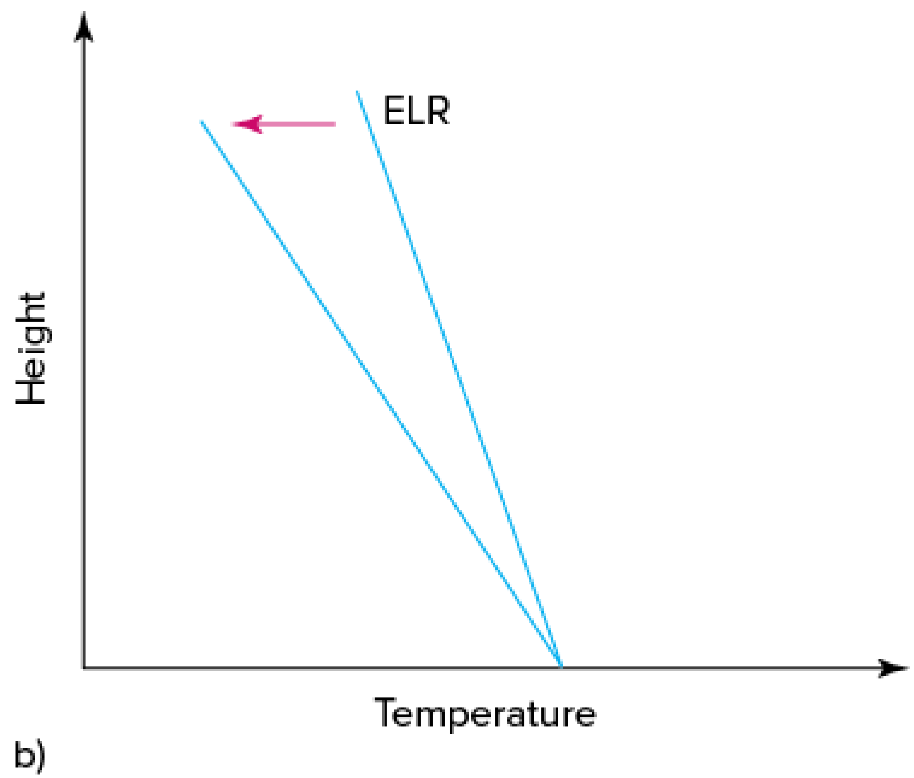


Fig 8.23

**Low level warming or cooling aloft *destabilize* the air column

Cooling at low level and/or warming aloft stabilize the column



NOT EXAMINABLE ON MIDTERM

Emagram – isotherms are vertical

Layer AB is absolutely stable & (let's assume) unsaturated

Idealized process: unsaturated layer AB is lifted as a whole

Layer expands: top (B) ascends further than base (A), thus layer A'B' thicker than AB

ELR of A'B' closer to DALR than was ELR in AB

The arguments of pages (5,6,7) are not "proofs" of the phenomena they describe: they are merely "suggestive" explanations

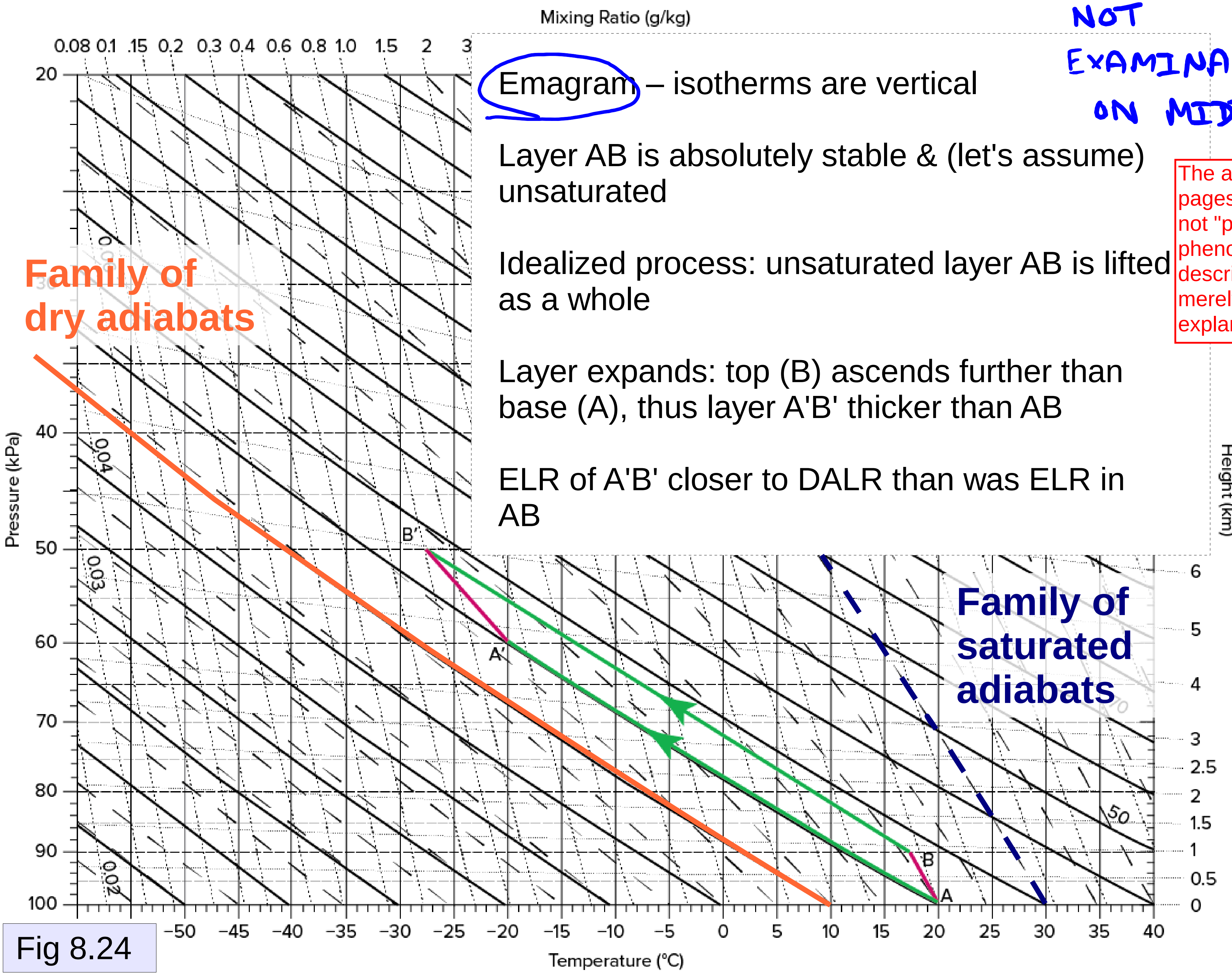
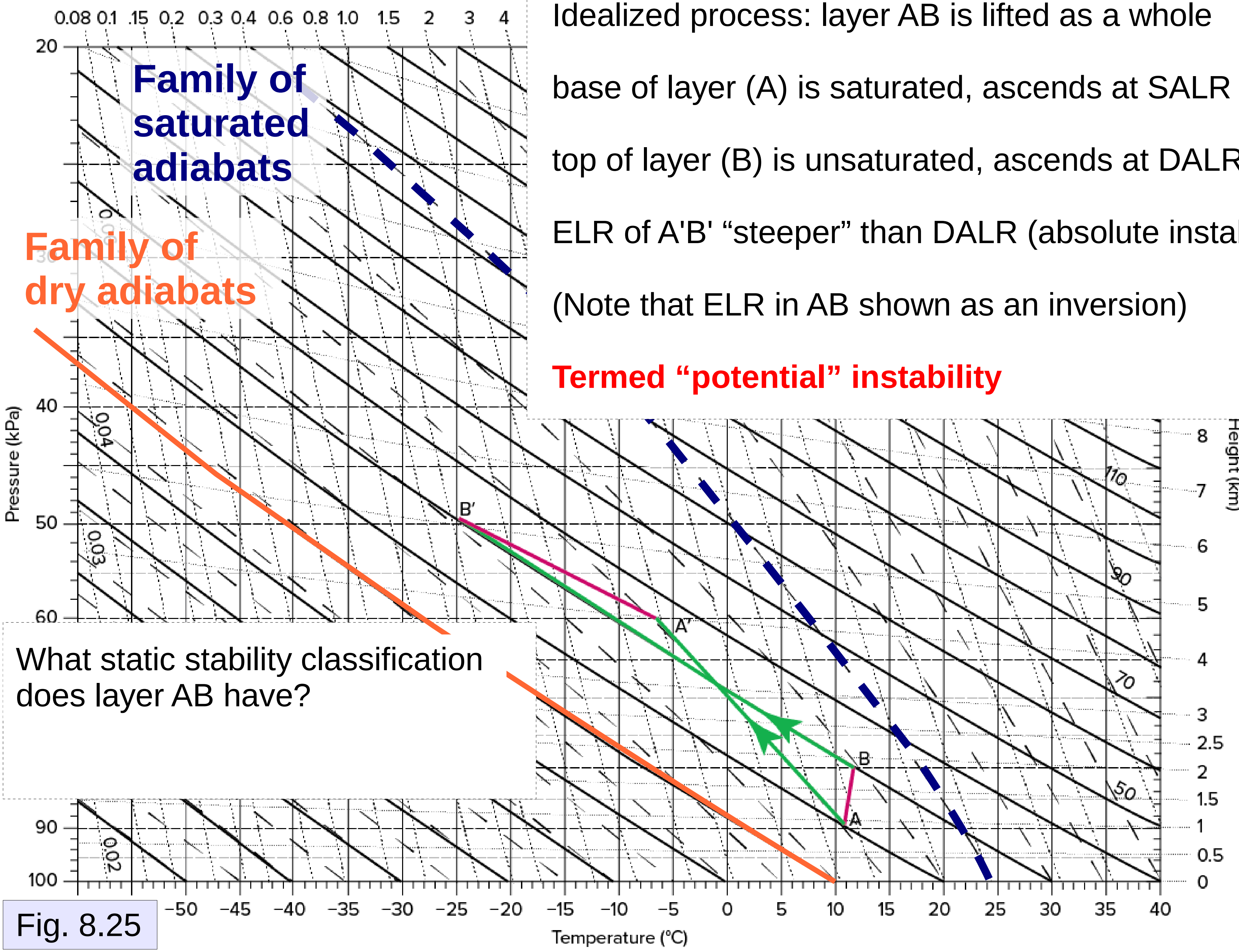


Fig 8.24

NOT EXAMINABLE ON MIDTERM



Idealized process: layer AB is lifted as a whole

base of layer (A) is saturated, ascends at SALR to A'

top of layer (B) is unsaturated, ascends at DALR to B'

ELR of A'B' "steeper" than DALR (absolute instability)

(Note that ELR in AB shown as an inversion)

Termed "potential" instability

What static stability classification does layer AB have?

Fig. 8.25

NOT EXAMINABLE ON MIDTERM

Idealized process: layer AB sinks as a whole

Top (B) and base (A) of layer both warm at DALR

Layer as a whole is compressed. B sinks further than A

ELR of A'B' an inversion (absolutely stable)

Termed "subsidence inversion"

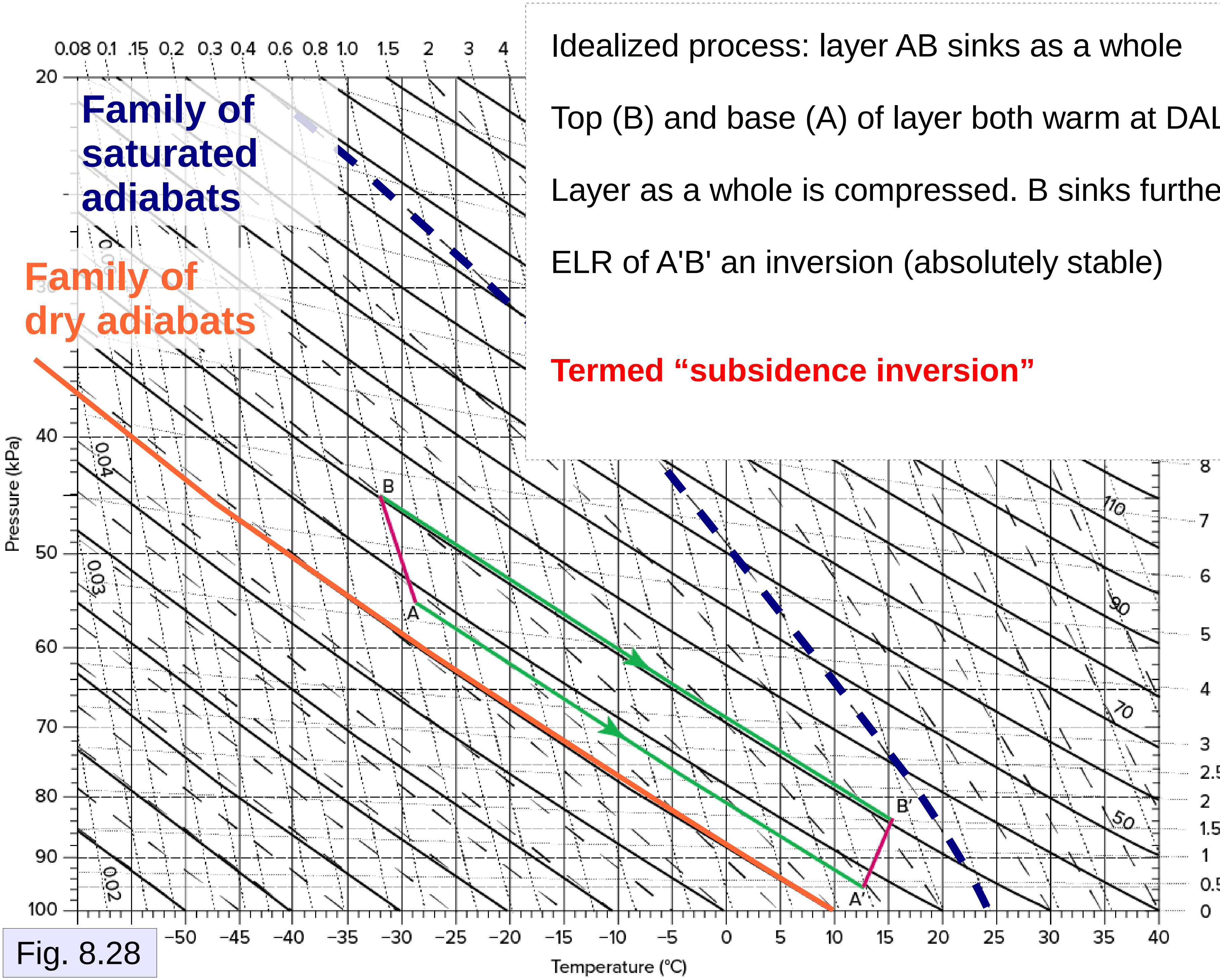
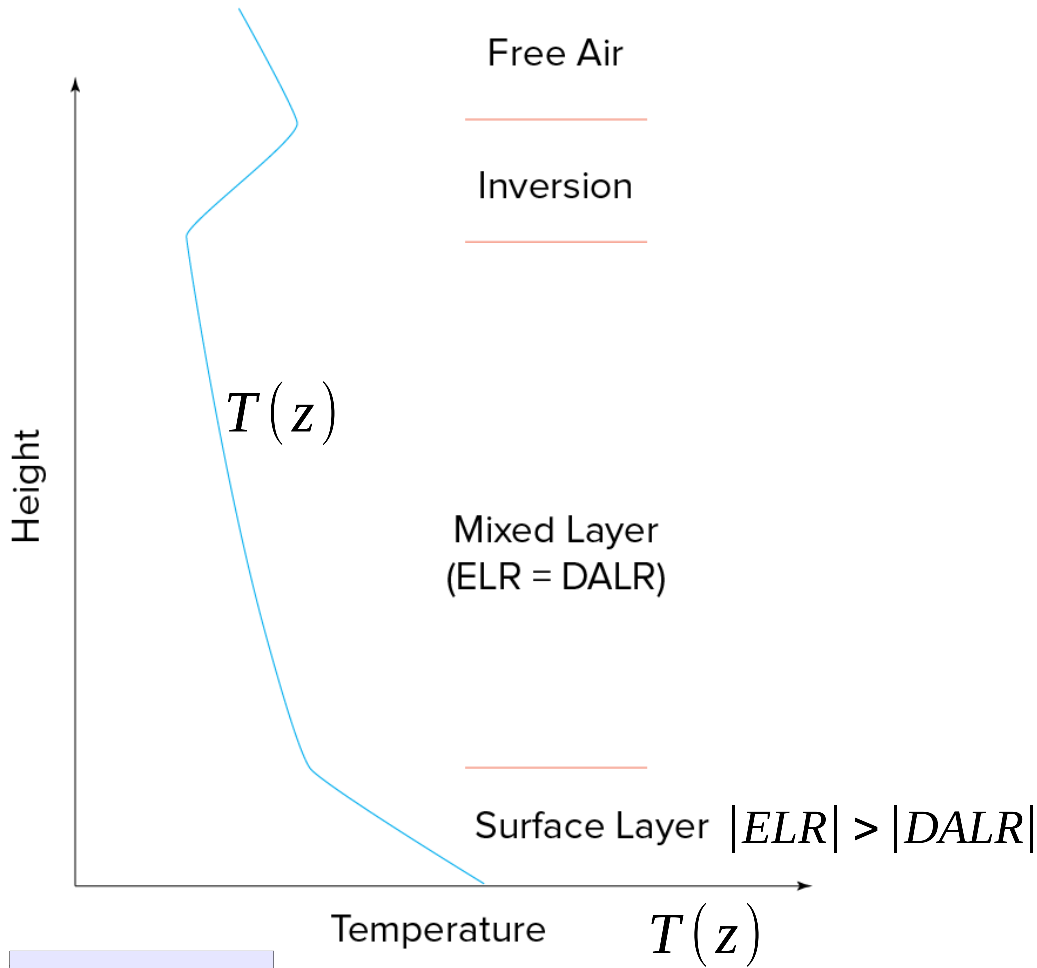


Fig. 8.28

Day: Surface Layer ("ASL"): approx. the lowest 100 m of the ABL

- site of strong vertical wind shear and strong vertical temperature gradient

Parcels rising out of the ASL will be warmer than their environment, giving upward buoyancy force



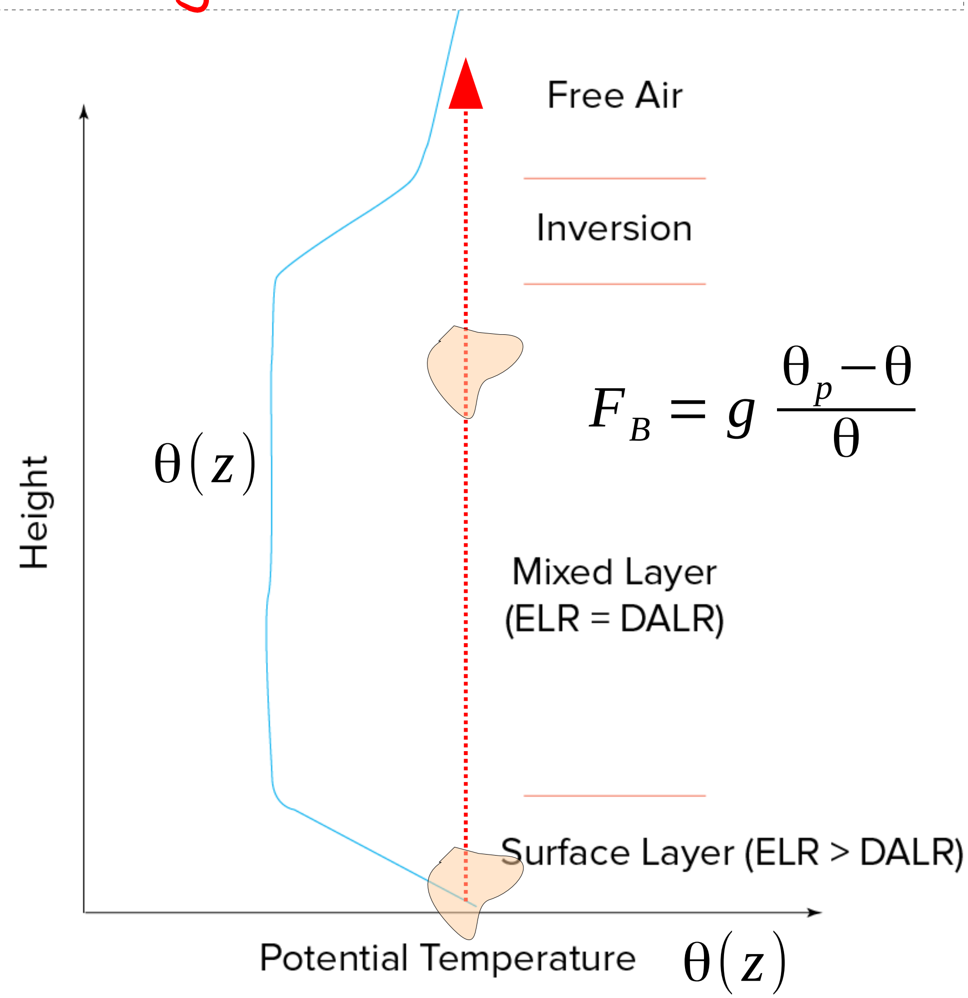


Fig 8.29a

Night:

$Q^* = L^* < 0 \Rightarrow Q_H < 0$

Parcels rising from ASL have $\theta_p < \theta_{env}$.

$\therefore F_B = g \frac{\theta_p - \theta_e}{\theta_e} < 0$

POOR MIXING
LIGHT WINDS

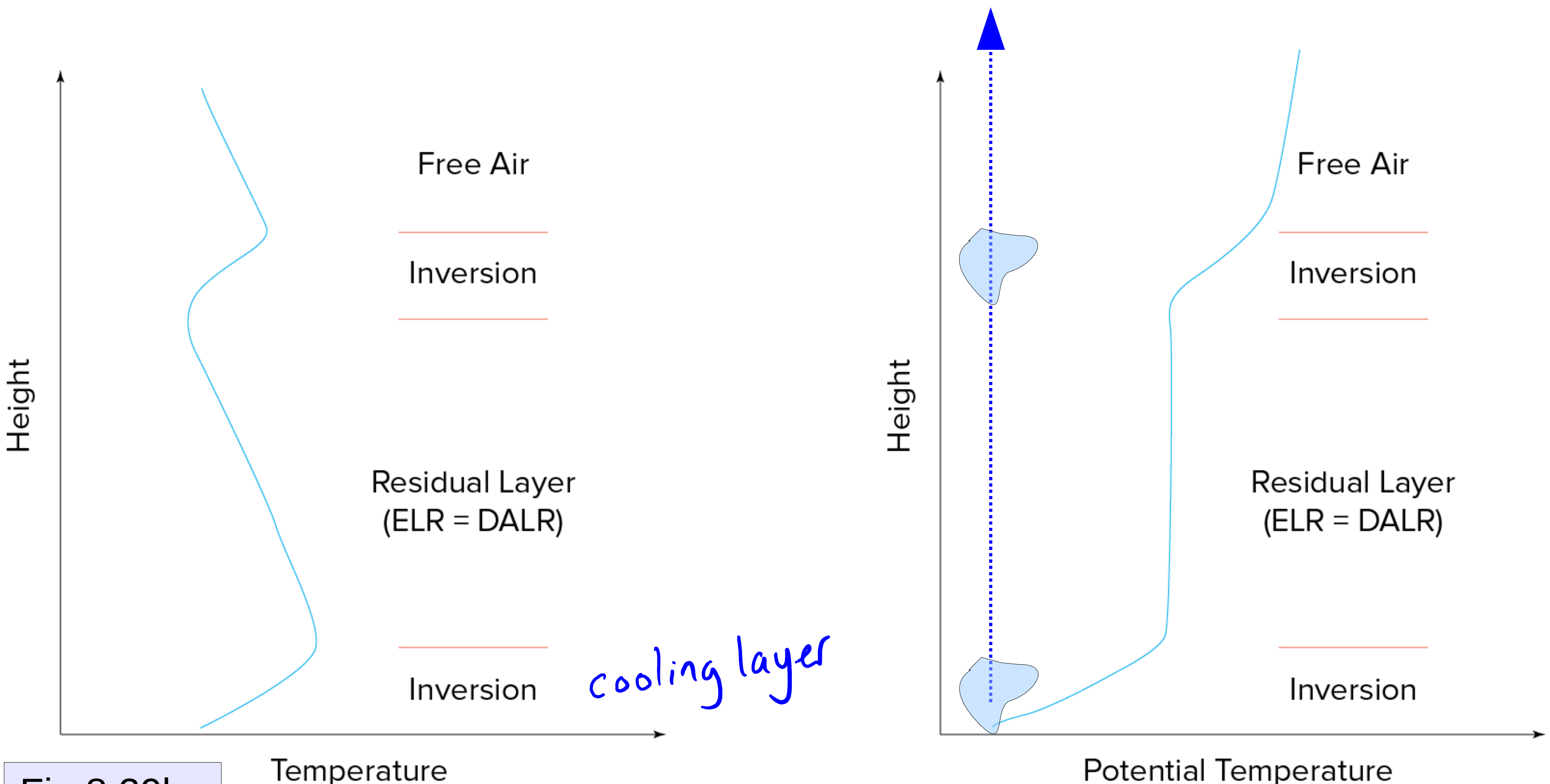


Fig 8.29b

Topics/concepts covered

- generalities as to where/when [unstable, condit. unstable, stable] layers are observed

- resulting change in the stability of a layer that is lifted or lowered

- character of the atmospheric surface layer (ASL)

- fairweather daily cycle in stratification of the ABL: typical height profiles of $T(z)$ and of $\theta(z)$ through the ASL to the top of the ABL and into the free atmos