3. The earth radiates primarily in the ___infrared/longwave___ range of the electromagnetic spectrum.

12. A deep convective cloud that results in rain and lightning is called? **Cumulonimbus**

13. Name a wispy high cloud that is composed of ice crystals. **Cirrus**

15. Clear-sky atmosphere is nearly (transparent, opaque) to solar radiation. As a result, most of solar radiation is absorbed (**on the ground**, by greenhouse gases).

16. Which day has the largest daily range of surface temperature?
   a. calm and clear-sky; b. windy; c. cloudy.

18. The term used for a line of constant pressure is **an isobar**.

21. In the weather reports on the right, the wind is from **southeast** at ___15___ knots.

23. The atmospheric pressure at a point is equal to the weight of all the air molecules above that point. **True** or **false**?

24. Water vapor **always** condenses when relative humidity exceeds 100%. **True** or **false**?

26. Which air parcel (of equal volume) contains more moisture?
   Parcel A (temperature -2°C and relative humidity 100%), and parcel B (temperature 10°C, dew point temperature 5°C). **Parcel B**
Lecture 8     Stability

Stability and Instability
Perturb and see whether the system returns to its original equilibrium.

Stable equilibrium

Unstable equilibrium
Stability in the Atmosphere

To determine the atmosphere’s stability for vertical motions, we need to compare the temperature of rising/sinking air parcels with the temperature in the surrounding environment.

Pressure $\sim$ Density $\times$ Temperature
$\Rightarrow$ The warmer the parcel, the lighter.

Rising air expands and cools; Sinking air compresses and warms.

Dry adiabatic lapse rate (10 °C/km): the rate of temperature decrease with height with no heat gain or loss.

Moist adiabatic rate (~6 °C/km): the rate of temperature decrease with height for a saturated air parcel (the latent heat of condensation makes it less than the dry adiabatic rate).
Absolutely stable
Near ground at night due to radiation cooling

Stable atmosphere inhibits vertical motion
e.g., radiation inversion
Unstable atmosphere
Heated ground on hot, sunny days; forecast fire

Conditionally unstable
Upon being lifted above the condensation level
Environmental Lapse Rate & Stability

Environmental lapse rates are said to be:

- **Absolutely stable** - if they have a value less than the moist lapse rate.
- **Conditionally unstable** - if they fall between the dry and moist adiabatic lapse rates.
- **Absolutely unstable** - if they have a value greater than the dry adiabatic lapse rate.

Mechanisms for cloud formation

- **Conviction** (6 km)
- **Topography** (150 km)
- **Low pressure** (500 km)
- **Lifting along weather fronts** (1500 km)
Atmospheric stability variation during a day

Absolute stable  Unstable near ground  Cumulus cloud

Convection visualized by shimmering air
Cumulus clouds form in convective thermals in a hot afternoon. Cycle of convection development: the clouds shield sunlight, cutting off surface heating & convection.

Cumulus clouds on a warm afternoon: a visual indicator for rising motion. Air sinks in clear areas between clouds.
Tropopause that caps the anvil cloud.

Thunderstorms (cumulonimbus) develop in a field of cumulus.

**Orographic uplift**

orographic rain; rain shadow