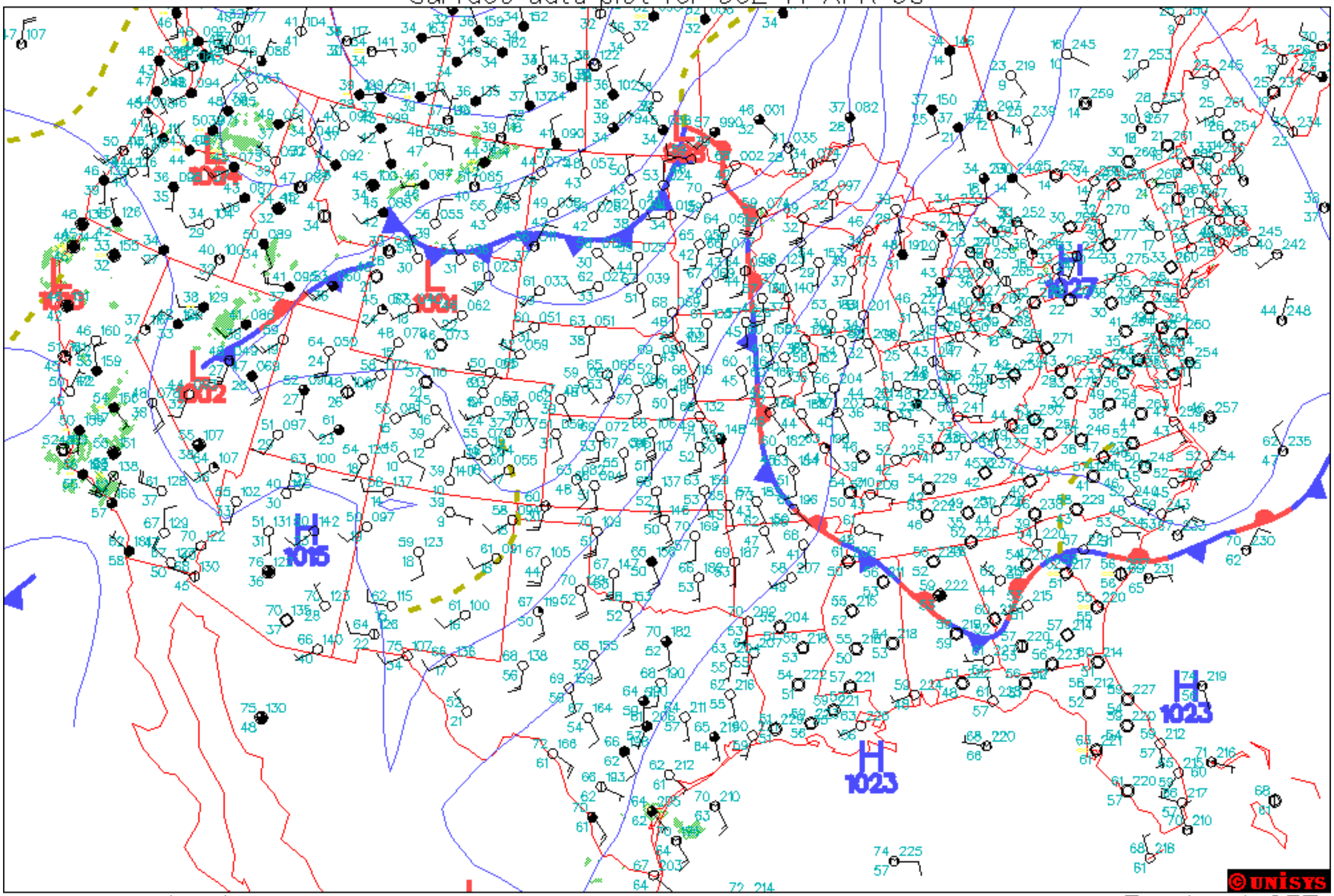
Lecture for Labs 1-3

GEOL 1147: Introduction To Meteorology Lab

Lab 1

Surface Weather Map

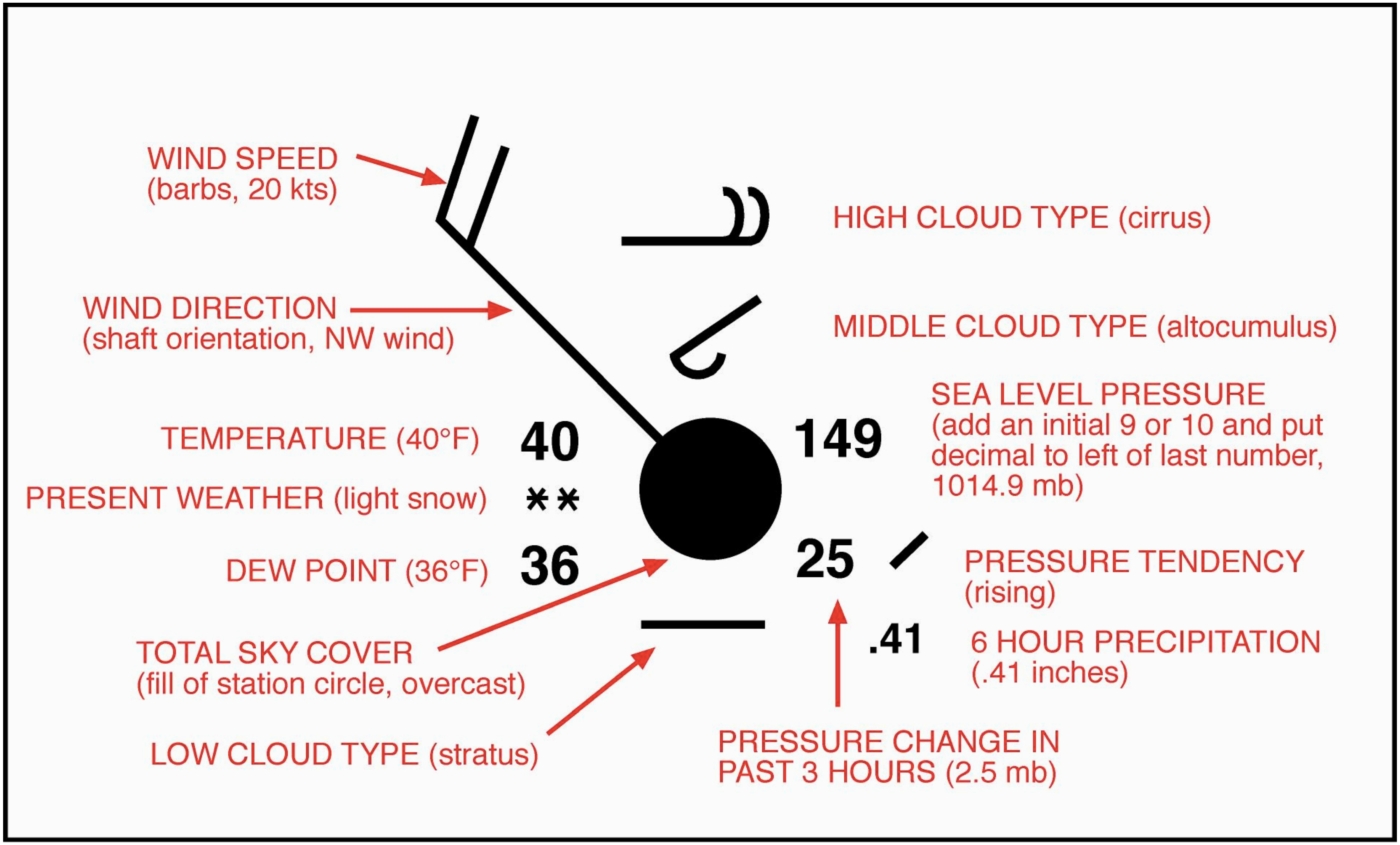
Surface data plot for 06Z 14 APR 03



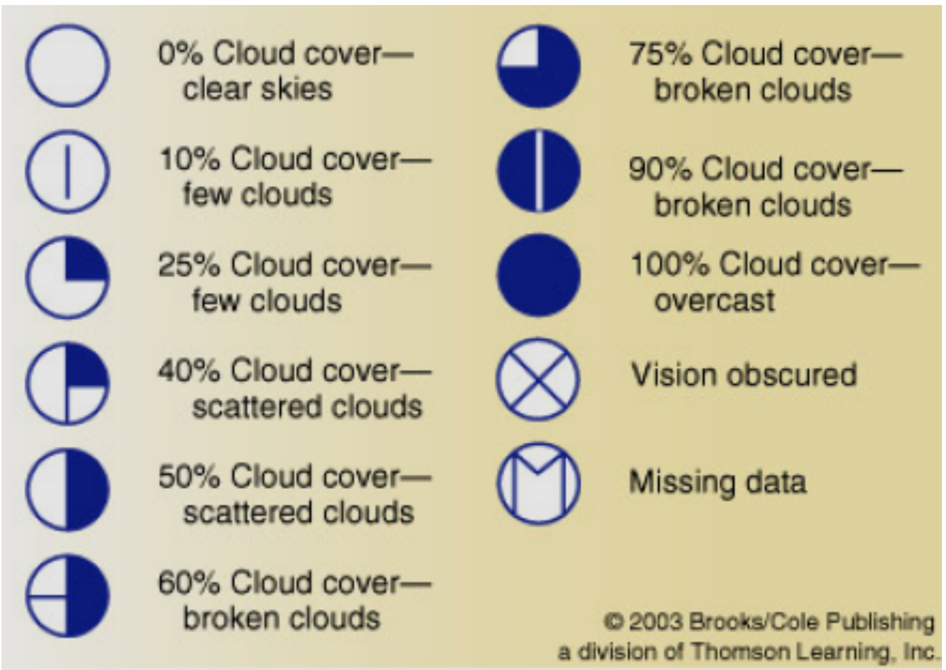
Intensities (Dbz): 20 30 40 45 50 55

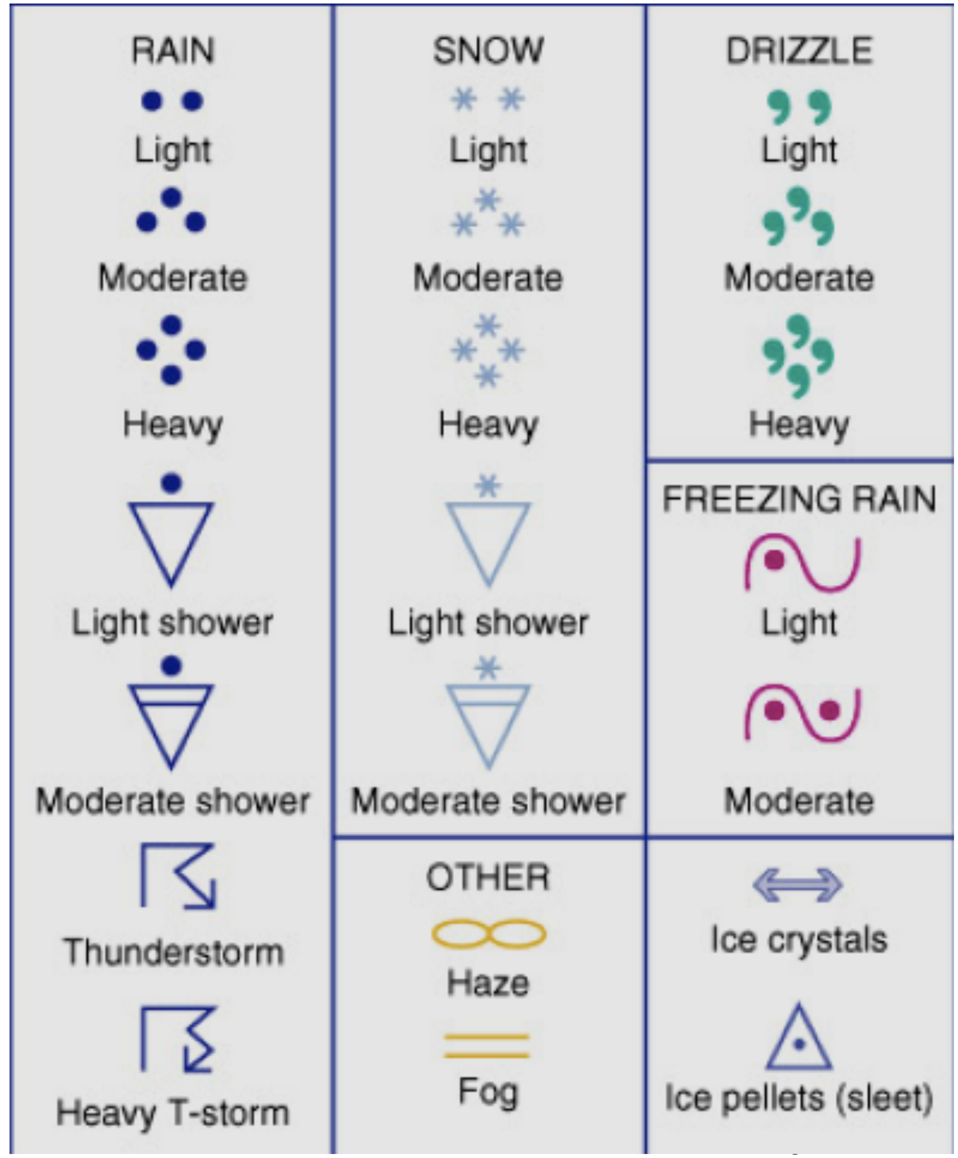
Fronts at 03Z

Surface Station Model



Surface Station Model



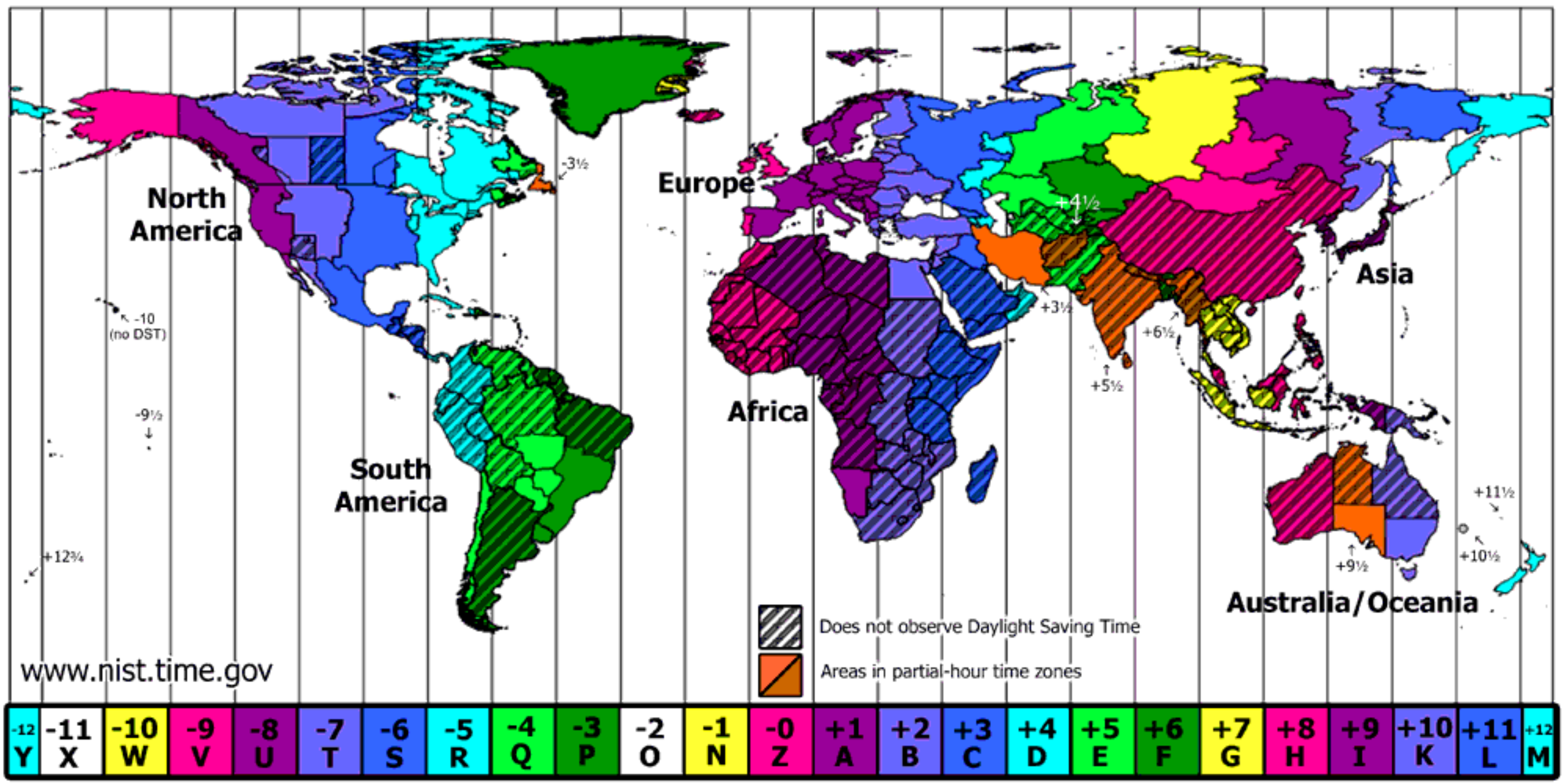


Surface Station Model

WIND SPEED

	miles per hour	kilometers per hour		miles per hour	kilometers per hour
	Calm	Calm		50–54	80–87
	1–2	1–3		55–60	88–96
	3–8	4–13		61–66	97–106
	9–14	14–19		67–71	107–114
	15–20	20–32	·		
	21–25	33–40	·		
	26–31	41–50	·		
	32–37	51–60		113–118	182–190
	38–43	61–69		119–123	191–198
	44–49	70–79			

Time Zones



North America
South America
Europe
Africa
Asia
Australia/Oceania
-3½
-10 (no DST)
-9½
+12¾
+4½
+3½
+6½
+5½
+11½
+10½
+9½
Does not observe Daylight Saving Time
Areas in partial-hour time zones
www.nist.time.gov
-12 Y
-11 X
-10 W
-9 V
-8 U
-7 T
-6 S
-5 R
-4 Q
-3 P
-2 O
-1 N
-0 Z
+1 A
+2 B
+3 C
+4 D
+5 E
+6 F
+7 G
+8 H
+9 I
+10 K
+11 L
+12 M

Time Zones

Different locations are located in different time zones.

Meteorologists report weather observations with a standard time, called Universal Time Coordinates (UTC).

UTC is also denoted by Greenwich Meridian Time (GMT) or Z time. This standard time corresponds to the time at Greenwich, England, located at 0° longitude.

To convert between local time and Z time, we need know how many hours difference between our location and Greenwich, England.

In winter, Houston is 6 hours behind Greenwich, England. In the Summer months (daylight saving time), the difference will be 5 hours.

Relative Humidity – R.H.

The ratio of the amount of water vapor in the air compared to the amount required for saturation.

R.H. = water vapor content / water vapor capacity

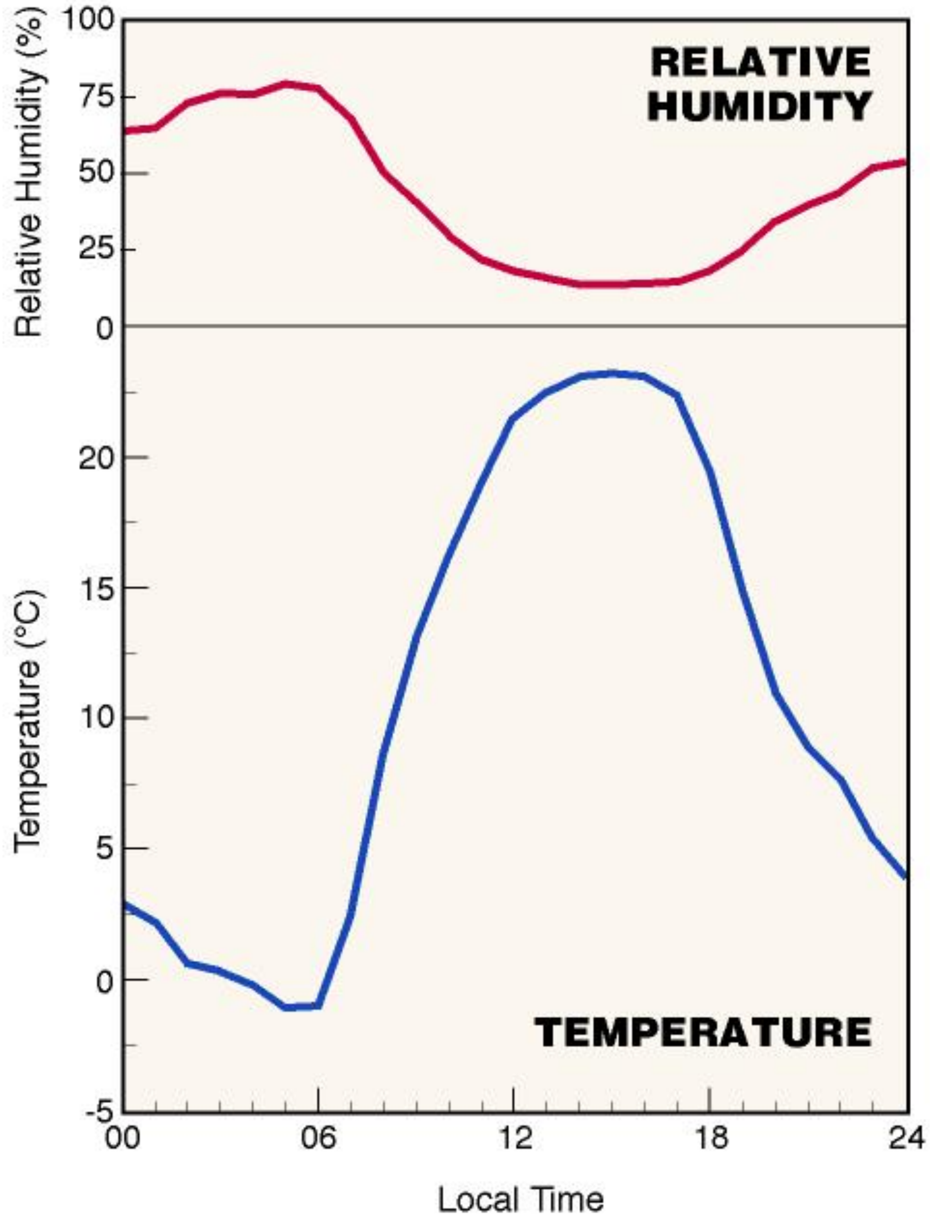
$$\text{R.H.} = \frac{e}{e_s(T)} = \frac{\tilde{n}_v}{\tilde{n}_{vs}(T)} = \frac{q}{q_s(T)} = \frac{r}{r_s(T)}$$

Higher relative humidity does not necessarily mean more water vapor in the air

Change of relative humidity in a day

What time of the day when relative humidity is usually high ?

As the air cools during the night, the relative humidity increases. The highest relative humidity occurs in the early morning, during the coolest part of the day.

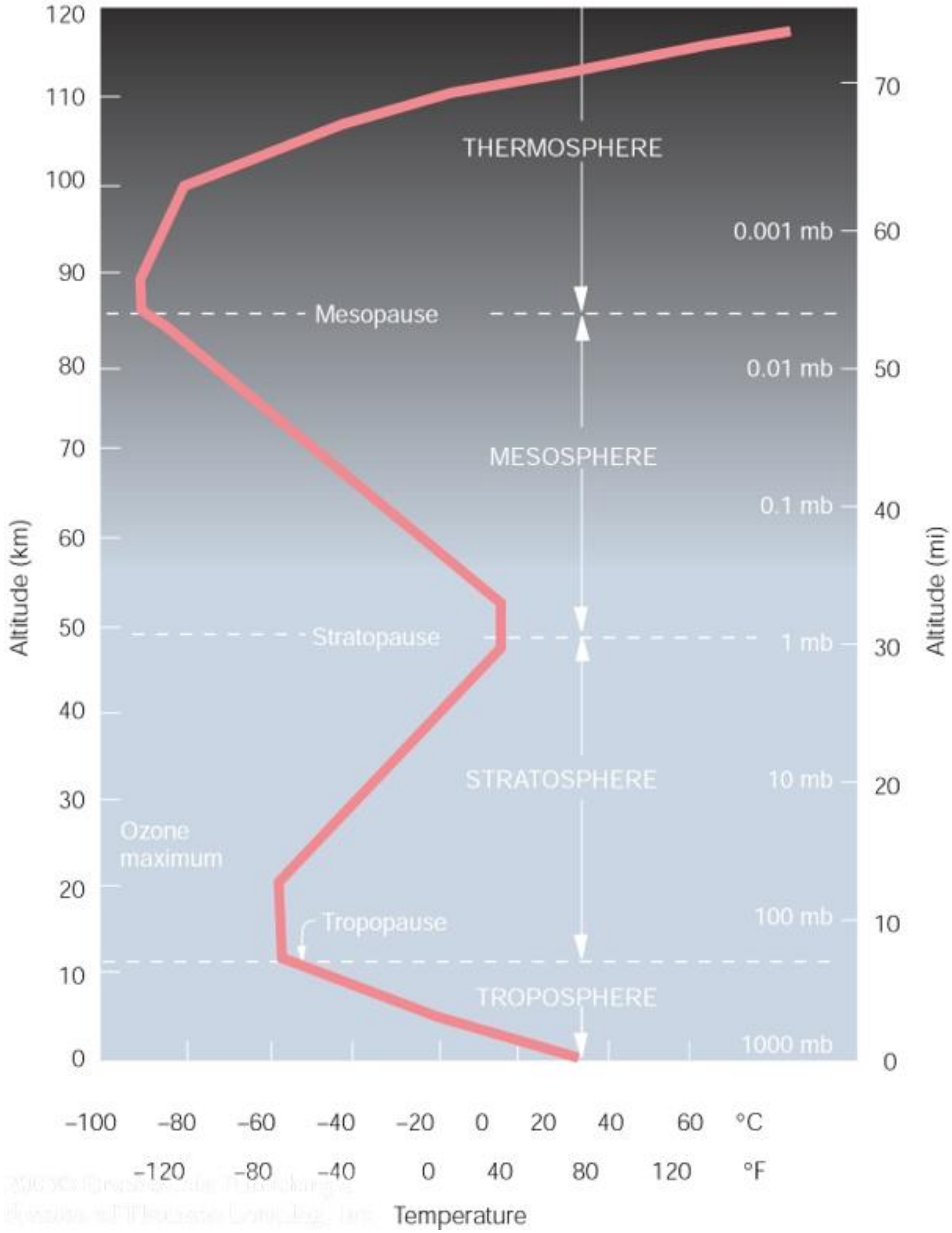


Dew Point Temperature - T_d

- Temperature to which air must be cooled (at constant pressure and constant water vapor content) to become saturated.
- When $T = T_d$, $e_s(T_d) = e$, $q_s(T_d) = q$, $r_s(T_d) = r$
- $T_d \leq T$
- Unlike relative humidity which is a measure of how near the air is to being saturated, dew point temperature is a measure of its actual moisture content. *The higher the dew point, the more water vapor in the air.*

- Dew point depression: $T - T_d$
- The larger the dew point depression is, the drier the air is, or the air is farther away from saturation

Lab 2



Thermosphere (85-500km): T increases with height. Absorption of highly energetic solar radiation by the small amount of residual oxygen.

Mesosphere (50-85 km): T decreases with height. No O_3 heating.

Stratosphere (11-50km); T increases with height as results of absorption of solar UV by stratospheric ozone.

Troposphere (0-11 km): T decreases with height at a rate of 6.5 K/km. Driven by surface heating.

Rate of cooling with increasing height (the 'lapse rate' or LR, expressed in °C per km)

$$LR = \frac{-1000 * (T_{upper} - T_{lower})}{Z_{upper} - Z_{lower}}$$

T is temperature and Z is height.

Lab 3

Basic laws for radiation

Stefan-Boltzman law: **The amount of energy per square meter per second that is emitted by a blackbody is related to the 4th power of its Kelvin temperature**

$$E = \sigma T^4$$

where E is in $J\ s^{-1}\ m^{-2}$ or Watts m^{-2}

$\sigma = 5.67 \times 10^{-8}\ W\ m^{-2}\ K^{-4}$ ***Stefan-Boltzman constant***

As T increases, E increases by a power of 4. If T doubles, E increases by 16 times!

A warmer object emits much more radiation than a cooler object

The Sun's radiation

$$E_{sun} = 5.67 \times 10^{-8}\ W\ m^{-2}\ K^{-4} \times 5780^{4}\ K^{4}$$

$$= 6.328 \times 10^{7}\ W\ m^{-2}$$

The Earth's Radiation

$$E_{earth} = 5.67 \times 10^{-8}\ W\ m^{-2}\ K^{-4} \times 288^{4}\ K^{4}$$

$$= 390\ W\ m^{-2}$$

$$E_{sun}/E_{earth} = (T_{sun}/T_{earth})^{4} = (6000/300)^{4} = 1.6 \times 10^{5}$$

Wien's law:

Wavelength of peak radiation emitted by an object is inversely related to temperature

$\lambda_{max} = 2897 / T \sim 3000/T$

(λ_{max} is in µm and T is in Kelvin)

Solar radiation : $\lambda_{max\ sun} \sim 3000/6000$ K ~ 0.5 µm,

Earth radiation: $\lambda_{max\ earth} \sim 3000/300$ K ~ 10 µm,

Solar radiation is shortwave radiation

Earth radiation is longwave radiation