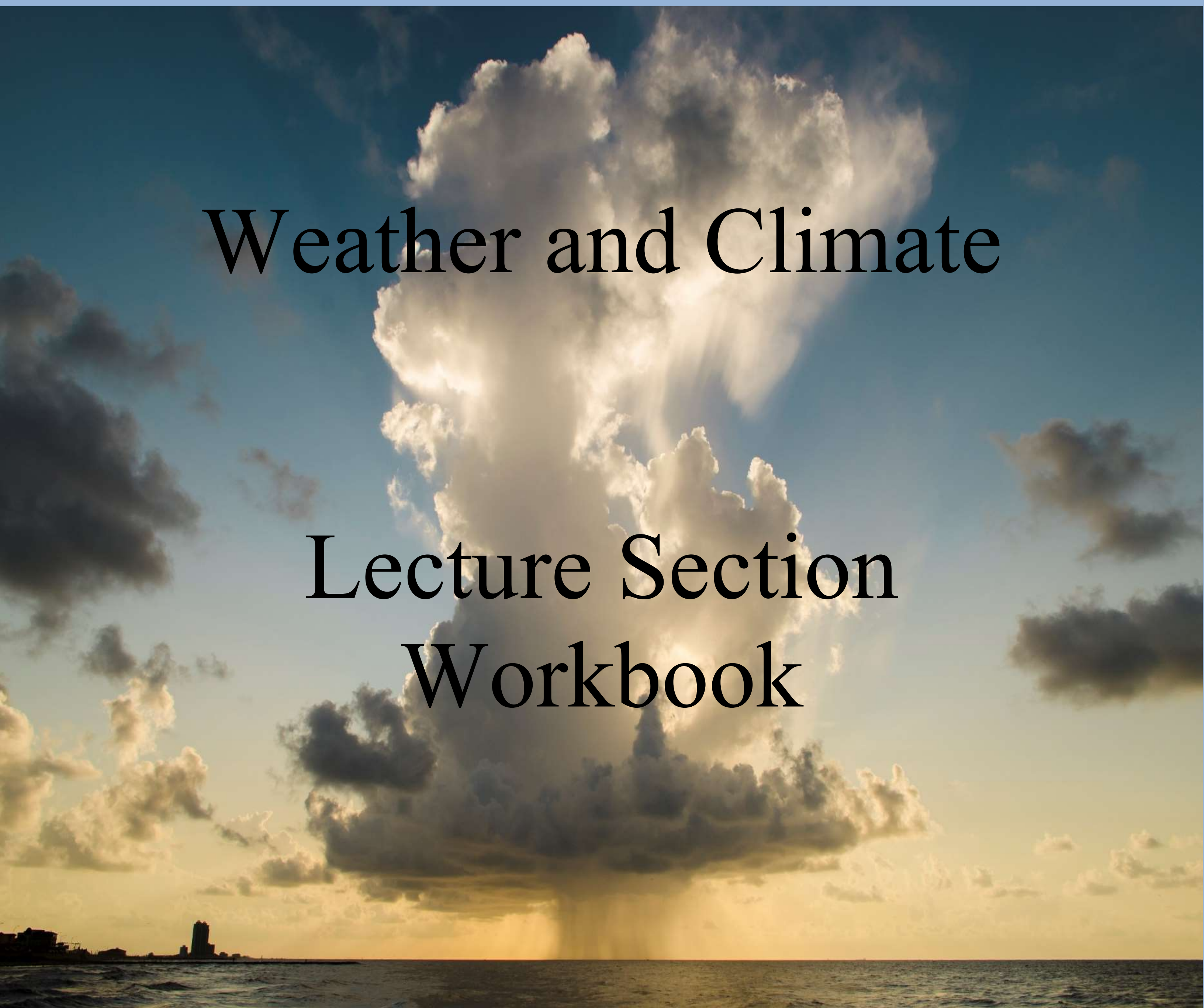


Weather and Climate

Lecture Section Workbook

Samantha Langton, PhD

Table of Contents

Assignment #1: Layers of the Atmosphere 1

Assignment #2: Heating of the Earth's Atmosphere 3

Assignment #3: Temperature Variations 5

Assignment #4: Humidity, Fog, and Clouds 7

Assignment #5: Adiabatic Lapse Rates and Cloud Formation 11

Practice Problems for Air Pressure and Isobar Maps (Not to Submit) 13

Assignment #6: Sea Level Corrections for Atmospheric Pressure and Introduction to Isobar Maps (For Submission) 15

Assignment #7: Atmospheric Circulations 17

Assignment #8: Weather Map Interpretation 19

Assignment #9: Thunderstorms and Tornadoes 23

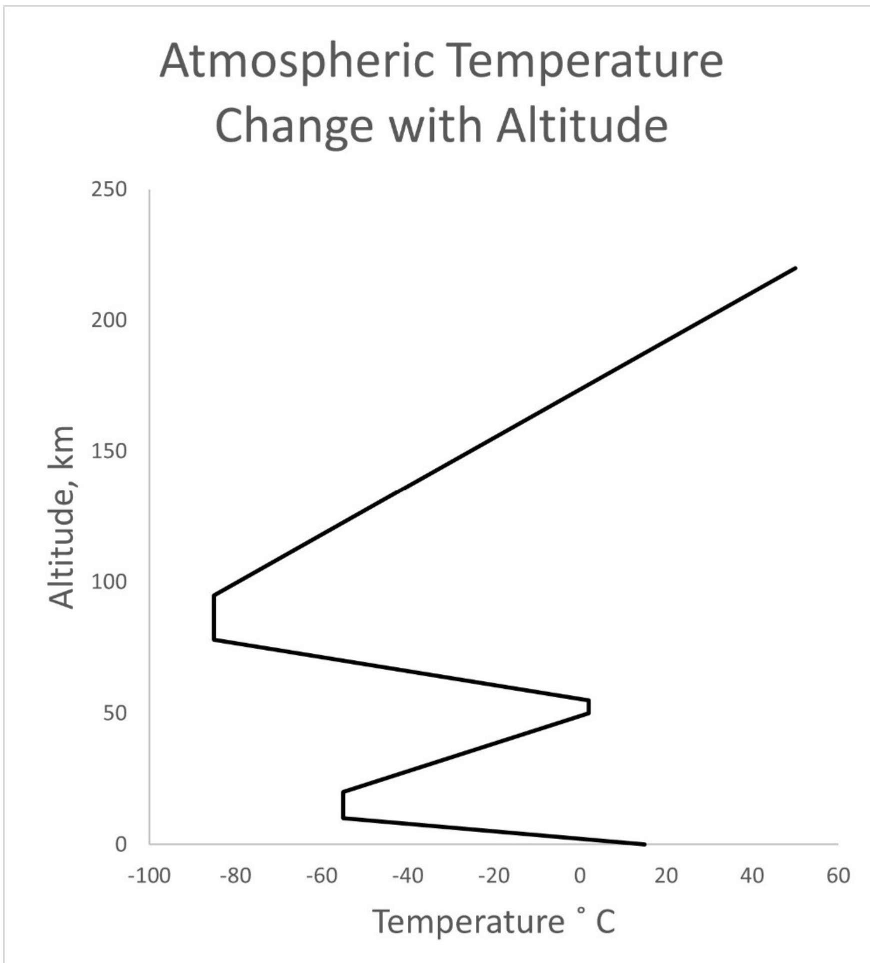
Assignment #10: Climate Change 29

PHS 111 Weather and Climate NAME:______________________________

DATE:________________________________

Assignment #1: Layers of the Atmosphere

1. Fill in the layers of the atmosphere and label the pauses on the diagram below, from the Troposphere to the Thermosphere.



2. Circle and label one ***inversion*** layer on the figure above.

3. Circle and label the layer that contains most of the ozone.

4. What force causes air molecules to have the highest density closest to the surface of the earth?

5. What is the average lapse rate of the Troposphere in ˚C/m?

6. If the surface temperature at sea level is 25˚C, what should the temperature be at 1000 m above sea level using the average lapse rate?

7. What is the average air pressure at sea level, in millibars (mb)?

PHS 111 Weather and Climate NAME:____________________________

DATE:_____________________________

Assignment #2: Heating of the Earth's Atmosphere

1. Go outside and estimate the temperature without looking at a thermometer or looking online. Next, look up the temperature in ˚F, outside at your location right now (you may use a weather app, like Hudson Valley Weather, The National Weather Service, Weather.com or Weather Underground, etc.). Next, convert the temperature to ˚C, and SHOW ALL work (3 points).

Estimated Temperature ˚F: _________________

Outdoor Temperature ˚F: ___________________

How close were you? Does it feel warmer or cooler outside than the measured temperature? Why do you think so?

<u>Convert to ˚C below:</u>

2. Your friend in Accra, Ghana, is complaining about the weather ***again***. They say that it is 28˚ C. What is this temperature in ˚F (Show All Work below for full credit)? Would you complain about this temperature right now?

3. Using Chapter 2 in your textbook as a reference, what time of day is typically the warmest? What time of day does solar radiation peak? Why are these two times different?

4. What form of radiation is responsible for heating the lower atmosphere at night?

Fill in the correct date(s) for each solstice and equinox in the Northern and Southern hemispheres:

	Northern Hemisphere	**Southern Hemisphere**
Vernal Equinox		
Autumnal Equinox		
Winter Solstice		
Summer Solstice		

PHS 111 Weather and Climate NAME:____________________________

DATE:______________________________

Assignment #3: Temperature Variations

1. What two factors have the greatest effect on daily temperature range?

2. What four factors have the greatest impact on regional mean temperature?

3. Give an example of a place (city, state, or region) that has a very large daily temperature range.

4. Give an example of a place (city, state, or region) that has a small daily temperature range.

5. How many heating degree days are added for a day that has an average outdoor temperature of 30˚ F?

6. How many cooling degree days are added for a day with an average of 85˚F?

PHS 111 Weather and Climate NAME:____________________________

DATE:______________________________

Assignment #4: Humidity, Fog, and Clouds

1. What type of still fog will form on clear nights or early mornings in the fall and winter?

2. What type of fog will form when warm, moist air moves over a colder surface?

3. What type of fog will form along an elevated surface, hill, or on the side of a mountain during winter or spring?

Name That Cloud!

For each of the following clouds:

1. Identify the cloud by its name.
2. Use Figure 4.36 on page 104 of the textbook to find the relative height of the cloud base and designate each cloud as "High," "Middle," or "Low."

1.

i 

Cloud Name: ____________________________

Relative Height: _________________________

2. 

ii

Cloud Name: ____________________________

Relative Height: _________________________

3.

iii

Cloud Name: ____________________________

Relative Height: _________________________

4.

iv

Cloud Name: ____________________________

Relative Height: _________________________

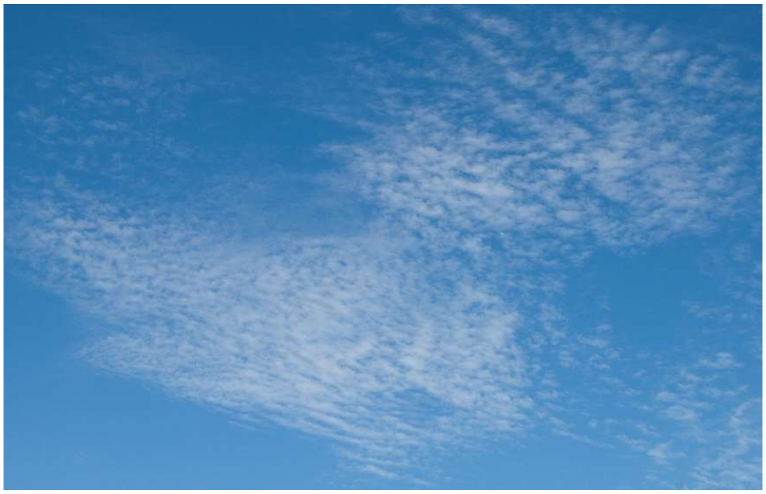
5.

Cloud Name: ____________________________

Relative Height: _________________________

v

6.



vi

Cloud Name: ____________________________

Relative Height: _________________________

PHS 111 Weather and Climate NAME:_____________________________

DATE:______________________________

Assignment #5: Adiabatic Lapse Rates and Cloud Formation

1. Figure out the lapse rates in ˚C/1000m and stability (absolutely stable, absolutely unstable, or conditionally stable) for each of the following environmental temperatures shown in the table below for each location. Location A is completed for you as an example.

Height (m asl)	Location A Temperature ˚C	Location B Temperature ˚C	Location C Temperature ˚C	Location D Temperature ˚C	Location E Temperature ˚C
0	22	20	32	25	15
500	20	15.5	26.5	19	10
1000	18	11	21	13	5
1500	16	6.5	15.5	7	0
2000	14	2	10	1	-5

Location A Lapse Rate: _____4˚C/1000m________________

Location A Stability: _____Absolutely Stable__________________

Location B Lapse Rate: ______________________

Location B Stability: ________________________

Location C Lapse Rate: ______________________

Location C Stability: ________________________

Location D Lapse Rate: ______________________

Location D Stability: ________________________

Location E Lapse Rate: ______________________

Location E Stability: ________________________

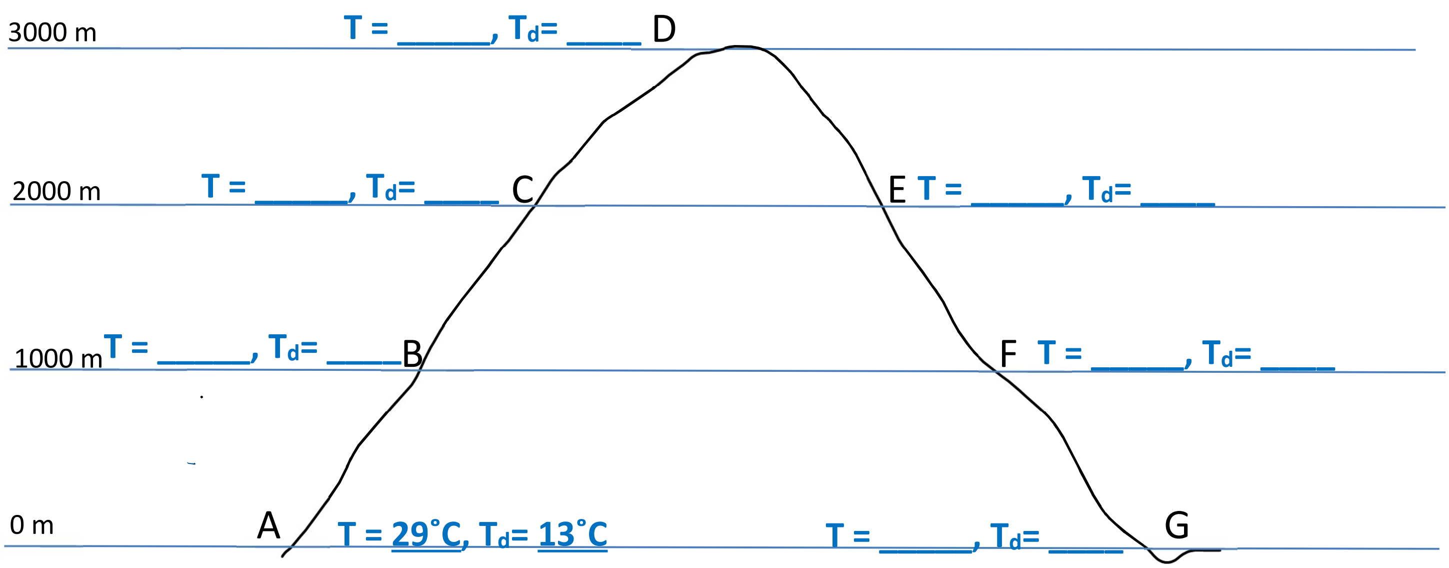
2. If the sea level dew point temperature is 16˚C at location C (in the table on the previous page), at what height in meters will clouds start to form? This level is called the "Lifting Condensation Level," or "LCL."

   Use this equation: $LCL = \dfrac{T\ ˚C - T_d\ ˚C}{8\ ˚C/km} \times 1000\ m/km$

   Where T = Air Temperature and T_d = Dew Point Temperature

3. Fill in the blanks for temperature and dew point on the diagram at the bottom of this page. Points A-D are on the windward side of the mountain. The temperature at point A is 29˚C dew point temperature at point A is 13˚C. Use the dry adiabatic lapse rate for the **air temperature** until the LCL is reached, where $T = T_d$. Draw a line at this level and label it "LCL." Below the LCL, use the Dew Point Lapse Rate of 2˚C/1000 meters for the Dew Point. Use a wet adiabatic lapse rate of 5˚C/1000m for all points above the LCL for the air temperature **and** the dew point. Assume that all points on the leeward side of the mountain are unsaturated. Use the dry lapse rate for the air temperature and the dew point lapse rate for the dew point temperatures going down the mountain. Remember that lapse rates are subtracted when air is lifted upwards, and lapse rates are added when air parcels are falling downward.

4. At which letter will a cloud start to develop?



PHS 111 Weather and Climate NAME:_____________________________

DATE:______________________________

Practice Problems for Air Pressure and Isobar Maps (Not to Submit)

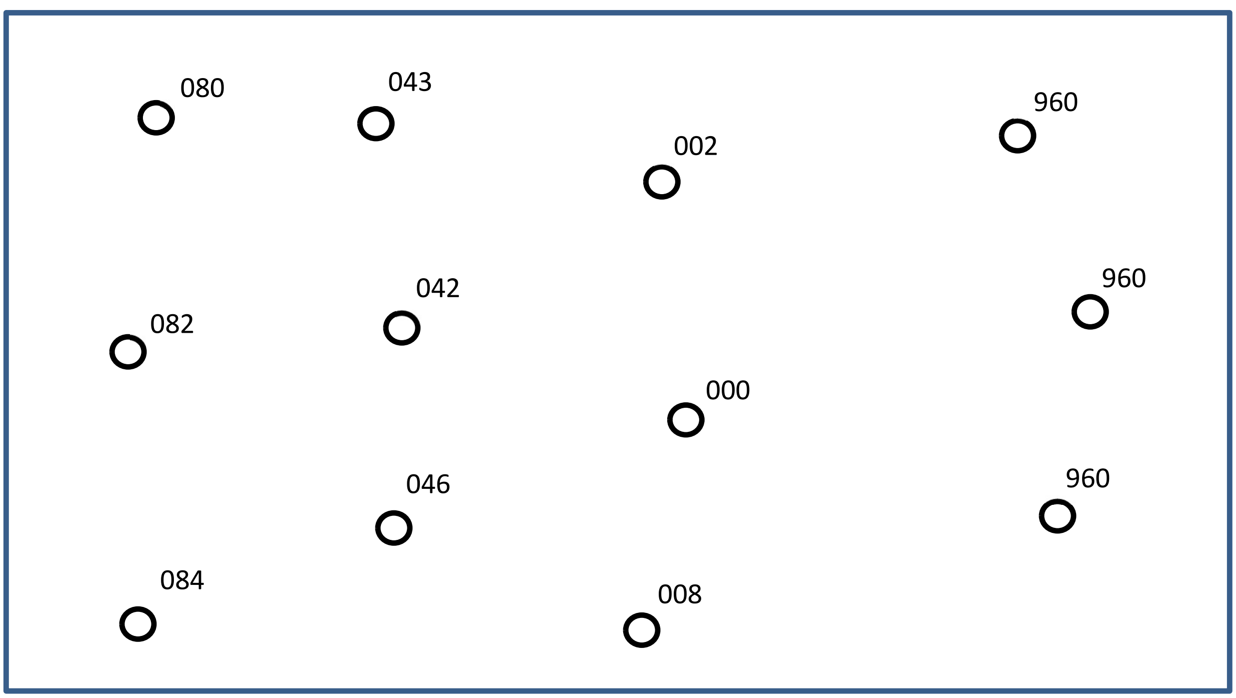
1. Correct the following air pressure readings for the air pressure at sea level:

    a. Station #1: 1000 m above sea level, the measured barometric pressure is 900 mb

    b. Station #2: 2,100 m above sea level, the measured barometric pressure is 790 mb

    c. Station #3: 2,750 m above sea level, the measured barometric pressure is 745 mb

2. a) Decode the air pressures at each station to show the actual air pressure in millibars. Write the corrected air pressure **above** each coded air pressure number.
    b) Draw isobars on the surface weather map shown below.
    c) Write in an "H" in the region of highest surface pressure and an "L" in the region of lowest surface pressure.
    d) Draw arrows to show the general direction of the wind.



PHS 111 Weather and Climate

NAME:___________________________

DATE:____________________________

Assignment #6: Sea Level Corrections for Atmospheric Pressure and Introduction to Isobar Maps (For Submission)

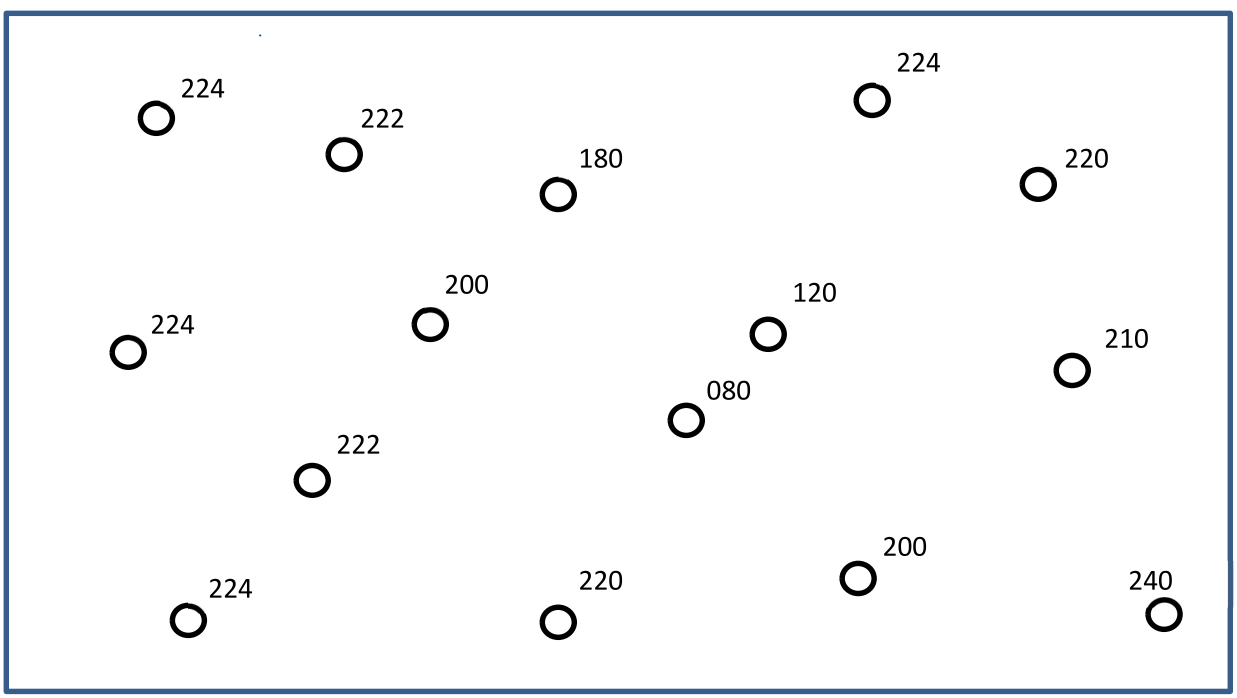
3. Correct the following air pressure readings for the air pressure at sea level (1 point each):

    a. Station #1: 1200 m above sea level, the measured barometric pressure is 890 mb

    b. Station #2: 2,750 m above sea level, the measured barometric pressure is 725 mb

    c. Station #3: 1,960 m above sea level, the measured barometric pressure is 810 mb

4. a) Decode the air pressures at each station to show the actual air pressure in millibars. Write the corrected air pressure **above** each coded air pressure number (2 points).
    e) Draw isobars on the surface weather map shown below (3 points).
    f) Write in an "H" in the region of highest surface pressure and an "L" in the region of lowest surface pressure (1 point).
    g) aw arrows to show the general direction of the wind (1 point).



PHS 111 Weather and Climate NAME:____________________________

DATE:______________________________

Assignment #7: Atmospheric Circulations

Match the definitions in the list with the letter of the correct term on the next page:

Definition	Matching Letter
Wind blowing past a chimney is an example of this scale of motion.	
Sudden change in wind speed or direction.	
Pressure systems that almost circulate the globe near latitude 30˚	
The sea breeze is an example of this scale of motion.	
Violent eddies that form beneath the wave crest downwind of a mountain.	
Semipermanent pressure system associated with the polar front.	
Warm ocean current that flows northward along the east coast of North America.	
The largest scale of atmospheric motions.	
The shallow, cold surface anticyclone observed over Asia during winter.	
The cold water episode that finds strong trade winds and unusually cold surface water in the central and eastern Pacific.	
Warming of the surface water of the tropical Pacific west of South America.	
Abbreviation for Clear Air Turbulence.	
The rising of cold water.	
Boundary separating the northeast trades and the southeast trades.	
Wind system that changes direction seasonally.	
Another name for a whirlwind.	
A Chinook wind in the Alps.	
A strong, often cold, downslope wind.	
The nighttime counterpart of sea breeze.	
Warm, dry wind associated with devastating fires in Southern California.	
A windstorm composed of dust and sand that forms along the leading edge of thunderstorm’s cold downdraft.	
Warm, dry wind that brings relief from the bitter cold on the eastern side of the Rockies.	
Fast flowing current of air concentrated in a narrow band.	

List of Terms:

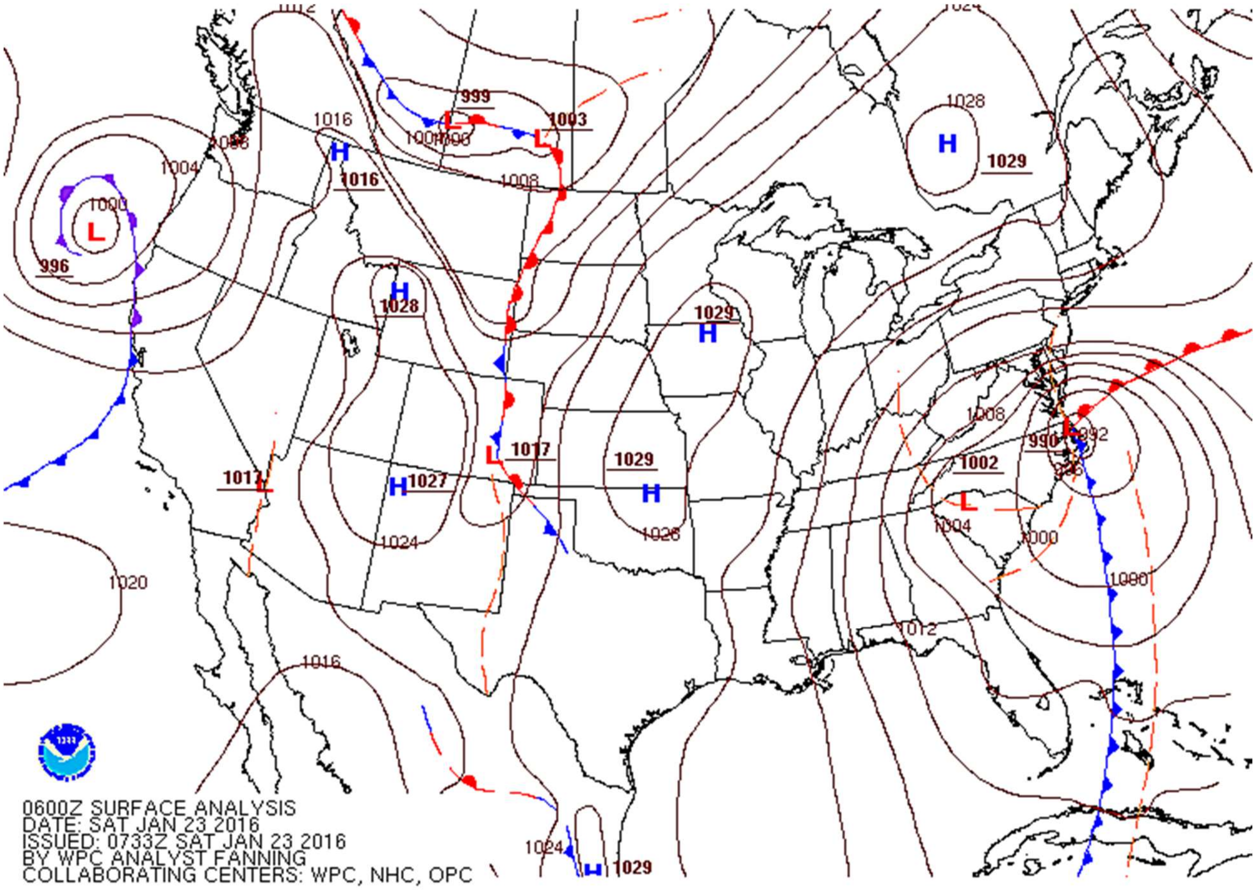
a. Santa Ana
b. Foehn
c. Land Breeze
d. Dust Devil
e. Chinook
f. Monsoon
g. Jet Stream
h. Haboob
i. Katabatic Wind
j. Rotors
k. Subtropical Highs
l. La Niña
m. Subpolar low
n. Microscale
o. Synoptic Scale
p. Upwelling
q. El Niño
r. ITCZ
s. Siberian high
t. Wind shear
u. Gulf stream
v. Mesoscale
w. CAT
x. Planetary scale

PHS 111 Weather and Climate NAME:___________________________

DATE:____________________________

Assignment #8: Weather Map Interpretation

Use the weather map below and Appendix C in your textbook to complete the following exercises.



1. Label each of the air masses on the map using the appropriate abbreviation.
2. Label each type of front shown on the map (Cold, Warm, Stationary, Occluded)
3. Draw arrows behind each front to show the direction in which each air mass is moving.

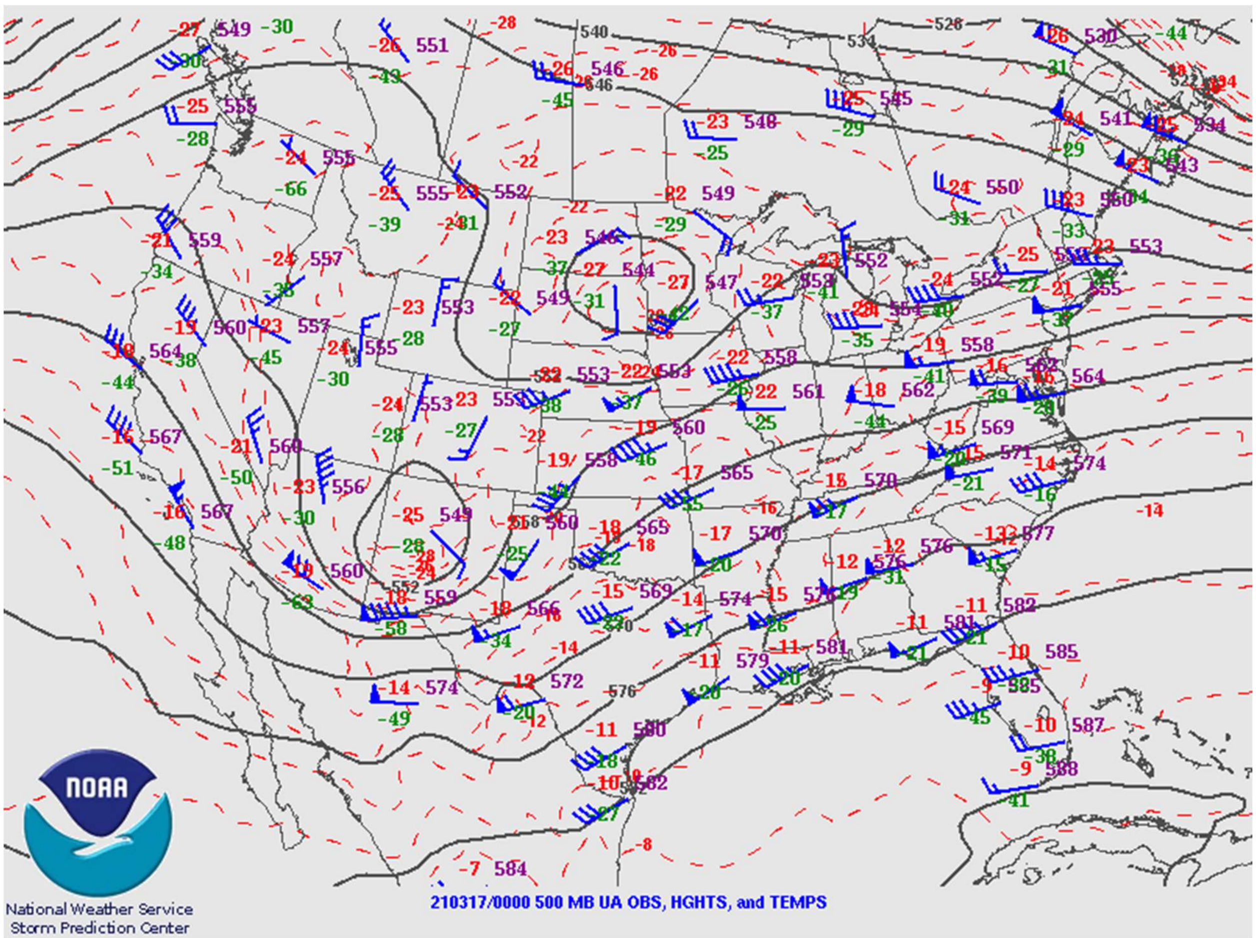
4. What type of front is associated with the following forecast:
South wind in the morning with mild temperatures in the upper 40s-50s. Thunderstorms in the mid afternoon will give way to clear skies and cooler temperatures in the upper 30s with wind direction changing to a northwest wind.

5. What type of front is associated with the following forecast:
Morning temperatures in the twenties and thirties. Overcast skies developing throughout the day. A steady, light rain will develop in the afternoon with warming temperatures into the fifties. Snow possible, less than one inch, grading into rain. Continued rain throughout the evening and into the next day. Warmer temperatures tomorrow in the low 50s with fog in the morning and clearing skies in the afternoon.

6. What type of front is associated with the following forecast:
Temperatures in the 40s in the early morning, warming slightly throughout the morning. Thunderstorms will come at around noon, followed by heavy and continuous rain showers grading into snow throughout the evening and into the next day. Thundersnow possible. Temperatures dropping into the upper 20s and low 30s by tomorrow with expected snow accumulation of 8-12 inches in the mid-Hudson valley.

7. Identify the following features on the upper air chart below. Use the abbreviations in parentheses to label each feature:

   a. Ridge Axis (R)
   b. Trough Axis (T)
   c. Convergence (C)
   d. Divergence (D)



PHS 111 Weather and Climate NAME:____________________________

DATE:______________________________

Assignment #9: Thunderstorms and Tornadoes

1. Draw a diagram showing and explaining the three stages of ordinary cell thunderstorm development on the following blank page.

2. Draw a fully-labeled diagram of a supercell diagram.

3. What type of storm system covers the largest areal extent?

4. What type of thunderstorm contains a mesocyclone?

5. Describe how a supercell thunderstorm develops.

6. Explain how lightning may form in a cloud and how it produces a lightning strike.

7. Explain how thunder is formed from a lightning stroke and why some observers will hear sound, while others may not.

8. What type of radar echo can be used to detect the development of supercell thunderstorms?

9. Define “derecho.”

PHS 111 Weather and Climate NAME:____________________________

DATE:_____________________________

Assignment #10: Hurricanes

1. Draw a cross-section of a hurricane. Label the eye, eyewall, rain bands, inflow, and outflow. Use figures 11.2 through 11.5 as reference.

2. What is the optimal minimum sea surface temperature for hurricane development?

3. How does El Nino/La Nina affect tropical cyclone development in the Pacific ocean?

4. Define and describe eyewall replacement.

5. List and describe the stages of hurricane development.

6. What scale is used to describe the strength of a tropical storm or hurricane?

PHS 111 Weather and Climate NAME:____________________________

DATE:_____________________________

Assignment #10: Climate Change

Instructions: Answer the following questions on this document or a separate document. Answers may be typed or hand-written. Please note that only answers derived from the textbook or lecture materials (including the videos) will be accepted. If answers are copied from an unacceptable source, you are in danger of violating the academic honesty policy and may receive no credit for this assignment.

1. Describe the differences between $\delta^{18}O$ data from air and water samples.

2. List 3 different paleoclimate proxies.

3. Approximately how many years before present did the following paleoclimate events occur (USE THE YEARS GIVEN IN THE LECTURE MATERIALS ONLY). Indicate whether the event was a relatively WARM or COLD period.
    a. The Last Glacial Maximum

    b. The Little Ice Age

    c. The Younger Dryas

    d. Holocene Warm Period

4. List and describe 4 different **natural** causes of climate change as described in the textbook and lecture.

[i] Kamil Nowacki, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons
[ii] John Robert McPherson, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons
[iii] GerritR, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons
[iv] Ron Clausen, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons
[v] Simon Eugster, CC BY-SA 3.0 Unported <https://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons
[vi] King of Hearts, CC BY-SA 3.0 <https://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons