

# EARTH SCIENCE REGENTS

## Reading Isobars

TEACHER VERSION – SEE LAST PAGE FOR RESOURCES

Name \_\_\_\_\_ Period \_\_\_\_\_ Lab # \_\_\_\_\_

*Copyright 1998 by S. Kluge, Updated by Z. Miller 2019*

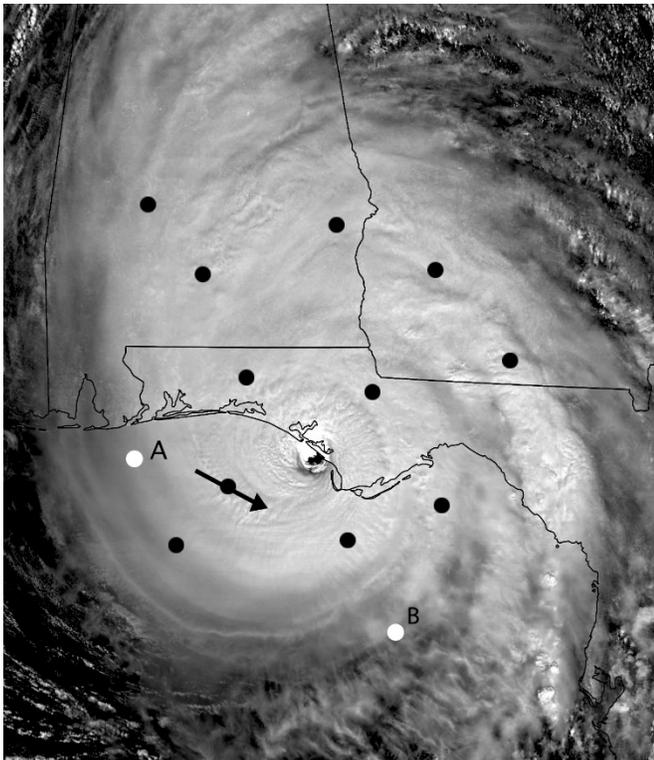
The accompanying map shows the Gulf of Mexico as Hurricane Michael traveled north heading for the northwestern Florida coastline on October 10, 2018. Hurricane Michael was notable for undergoing two rapid intensification periods (an increase in wind speed of 35 mph (miles per hour) in less than 24 hours) leading to 160 mph winds at landfall. The gray areas are land areas. The small dots surrounded by numbers and letters are station models. The data was collected at land based weather stations, aboard ships and oil rigs, and remotely sent by radio from weather buoys anchored in the Gulf. Radio waves are absorbed by water, so data transmitted from remote stations can be lost in high seas and/or heavy rain. The most reliable information comes from manned, land based stations. The isolines are isobars.

1. Label Florida (FL) in small letters at Lat. +29 Long. -82.
2. Label Cuba (CUBA) at Lat. +22.5 Long. -81.
3. Label the Texas coast (TX) at Lat. +29 Long. -97.
4. Label Louisiana (LA) at Lat. +30.5 Long. -91.
5. Label the Yucatan Peninsula (YUC) at Lat. +19.5 Long. -89

Examine the station models and the isobars on the map.

6. Are the pressures at the station models coded? \_\_\_\_\_
7. Describe the wind direction in the area between by Lat +22 and Lat. +30 and Long -82 and Long. -92.

8. Is that description in agreement with what you know about the movement of air around low pressure systems?



8A. The image to the left was made on 10/10/2018 (the same day the map was made) and several points (have been added to the image for this lab. At each of the points, draw a small (1 cm length) arrow to indicate the direction of air flow at that point. One arrow has already been drawn.

Is the air flow pattern you've drawn consistent with your answer to # 7 above? \_\_\_\_\_ If not, examine the map again and re-write your answer to # 7.

8B. Mark the area of lowest pressure with the letter "L"

8C. Draw possible station models at points "A" and "B"

8D. Write a sentence describing the direction of air flow around a Low pressure system

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

See the web address below for a visible loop of Michael

[https://cimss.ssec.wisc.edu/goes/blog/wp-content/uploads/2018/10/181010\\_goes16\\_visible\\_Hurricane\\_Michael\\_anim.mp4](https://cimss.ssec.wisc.edu/goes/blog/wp-content/uploads/2018/10/181010_goes16_visible_Hurricane_Michael_anim.mp4)

9. Look at your map again. Are the isobars on the map coded? \_\_\_\_\_

On the map, locate the isobar labeled "10" (at Lat. +21 Long. -84).

10. What is the decoded pressure along that isobar? \_\_\_\_\_

Notice the labels on the isobars surrounding the "10" isobar.

11. What is the isobar interval of this map? \_\_\_\_\_
12. What is the highest wind speed reported on the map? \_\_\_\_\_
13. What is the lowest pressure reported on the map? \_\_\_\_\_
14. What is the location of the station reporting the highest wind speed and lowest pressure?  
(To the nearest 0.1 degree)

Lat. \_\_\_\_\_ Long. \_\_\_\_\_

15. Determine the pressure gradient expressing your answer to the nearest thousandth (**0.001**) from the center of the storm (marked with a dot (●) within the eye at Lat. +27.7 Long. -86.6, pressure 945 mb) to a gray dot (●) at Lat. +30 Long. -80 northeast of the storm's eye.

Rise = \_\_\_\_\_ mb

Gradient = \_\_\_\_\_ mb/NM

Run = \_\_\_\_\_ NM

16. Determine the pressure gradient expressing your answer to the nearest thousandth (**0.001**) from the center of the storm (marked with a dot (●) within the eye at Lat. +27.7 Long. -86.6, pressure 945 mb) to a gray dot (●) at Lat. +25.5 Long. -93. Make sure you record units, too!

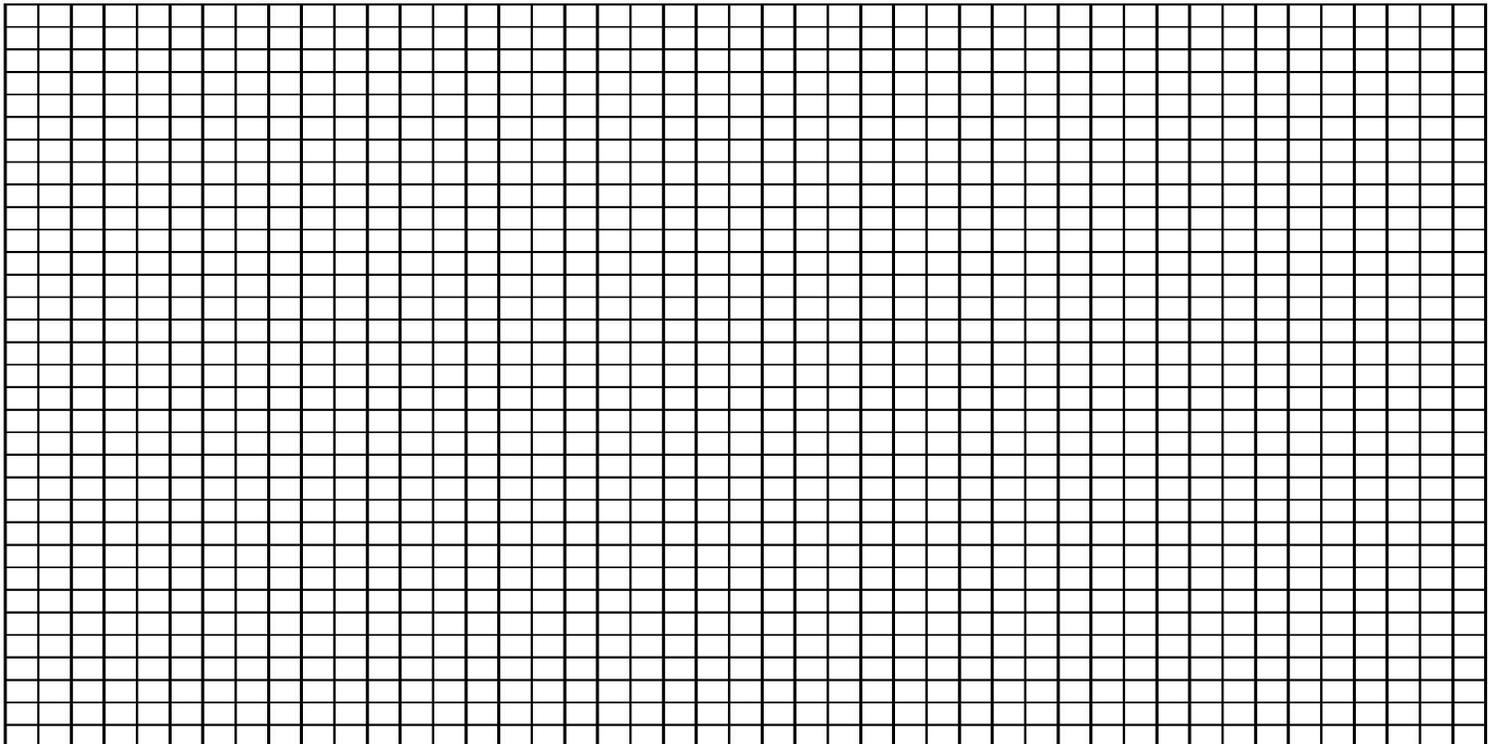
Rise = \_\_\_\_\_

Gradient = \_\_\_\_\_

Run = \_\_\_\_\_

Draw a line from the two gray dots (●) at Lat. +25.5 Long. -93 to Lat. +30 Long. -80. Label the appropriate ends of the line "NE" and "SW".

17. Use the graph paper below to construct a profile of the storm from SW to NE. Label everything and remember that neatness counts!



Carefully and thoughtfully answer/do the following:

18. According to your graph, on which "side" of the storm is the pressure gradient steepest? \_\_\_\_\_

19. According to your graph, on which "side" of the storm is the pressure gradient smallest? \_\_\_\_\_

20. How do those observations compare with the gradients you calculated in questions 15 and 16 above?

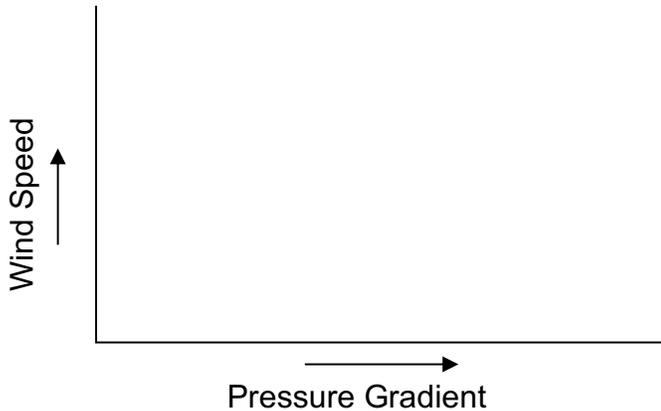
\_\_\_\_\_

21. Does there seem to be a relationship between pressure gradient (as indicated by close spacing of isobars) and wind speed? \_\_\_\_\_. On which "side" of the storm is the wind speed the greatest? \_\_\_\_\_

22. Write a sentence describing how wind speed is related to pressure gradient? \_\_\_\_\_

\_\_\_\_\_

23. Draw the graph below:



**CHALLENGE:**

Go to the following website showing a cloud intensity loop for Hurricane Michael:

[https://cimss.ssec.wisc.edu/goes/blog/wp-content/uploads/2018/10/181010\\_goes16\\_infrared\\_zoom\\_Hurricane\\_Michael\\_anim.mp4](https://cimss.ssec.wisc.edu/goes/blog/wp-content/uploads/2018/10/181010_goes16_infrared_zoom_Hurricane_Michael_anim.mp4)

Answer the following questions:

1. As hurricanes come on shore, on which side of the storm (east or west) is damage from wind and storm surge going to be the greatest? \_\_\_\_\_ EXPLAIN: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



## TEACHER RESOURCES

The items below are supplements to the above Hurricane Michael lab activity. These resources include satellite images & loops (animations), articles, tutorials on cyclone and hurricane development, and a variety of resources that can accompany this lab activity.

\*\*Animation/Loop included in the lab above.

### University of Wisconsin-Madison

Hurricane Michael Visible Satellite Loop – October 9, 2018

[https://cimss.ssec.wisc.edu/satellite-blog/wp-content/uploads/2018/10/181009\\_goes16\\_visible\\_Michael\\_anim.mp4](https://cimss.ssec.wisc.edu/satellite-blog/wp-content/uploads/2018/10/181009_goes16_visible_Michael_anim.mp4)

Hurricane Michael Infrared (approaching landfall) Satellite Loop – October 10, 2018

[https://cimss.ssec.wisc.edu/satellite-blog/wp-content/uploads/2018/10/181010\\_goes16\\_infrared\\_Hurricane\\_Michael\\_anim.mp4](https://cimss.ssec.wisc.edu/satellite-blog/wp-content/uploads/2018/10/181010_goes16_infrared_Hurricane_Michael_anim.mp4)

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\*\*Hurricane Michael Infrared (at Landfall) Zoom Satellite Loop – October 10, 2018

[https://cimss.ssec.wisc.edu/goes/blog/wp-content/uploads/2018/10/181010\\_goes16\\_infrared\\_zoom\\_Hurricane\\_Michael\\_anim.mp4](https://cimss.ssec.wisc.edu/goes/blog/wp-content/uploads/2018/10/181010_goes16_infrared_zoom_Hurricane_Michael_anim.mp4)

Top Directory (folder) of resources from University of Wisconsin-Madison (where above animations were found):

<https://cimss.ssec.wisc.edu/satellite-blog/wp-content/uploads/2018/10/>

### Weather Underground

Hurricane Michael Upgraded to Category 5 at Landfall:

<https://www.wunderground.com/cat6/Hurricane-Michael-Upgraded-Category-5-Landfall>

### New York Times

Among the Ruins of Mexico Beach Stands One House, Built 'for the Big One'

<https://www.nytimes.com/2018/10/14/us/hurricane-michael-florida-mexico-beach-house.html>

### NASA – How Do Hurricanes Form?

<https://pmm.nasa.gov/education/articles/how-do-hurricanes-form>

### NASA Earth Observatory

Florida Slammed by Hurricane Michael

<https://earthobservatory.nasa.gov/images/92868/florida-slammed-by-hurricane-michael>

### Inside Hurricane Michael as it made landfall (ABC video footage)

<https://www.youtube.com/watch?v=gyT7FR4Ums&t>

### Extreme 4K Video of Category 5 Hurricane Michael (storm chaser footage)

<https://www.youtube.com/watch?v=wSXvcveNSTQ>

### NATIONAL HURRICANE CENTER and CENTRAL PACIFIC HURRICANE CENTER

<https://www.nhc.noaa.gov>