Meteorology 2020 Invitational Test

Johns Hopkins University

February 8, 2020

Scores: A: ____/20

B:_____/18

C:_____/32

D:_____/30

Total ___/100

Tiebreakers: 1. Score on Problem 5 ___

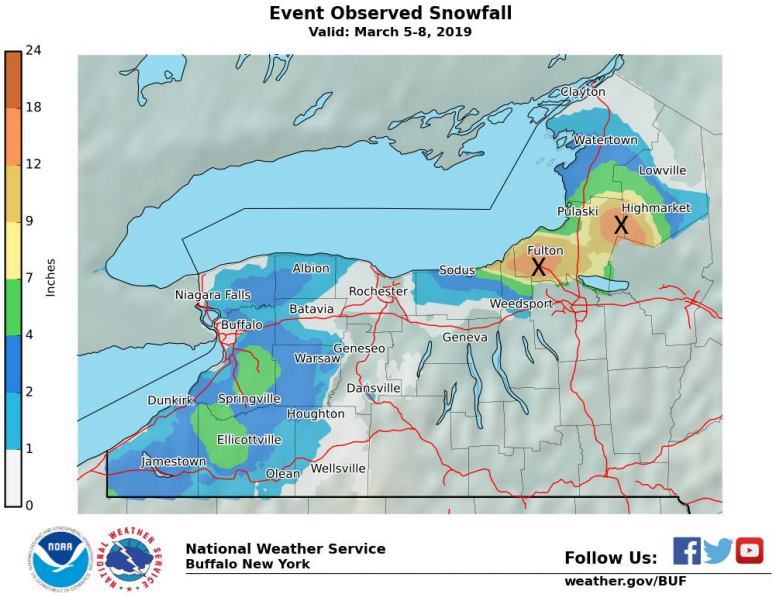
2. Score on Problem 12 ___

3. Score on Section A ____

4. Score on Section D ____

5. Score on Section B ____

6. Score on Section C ____



A. Winter stormsThe following questions refer to the plot at left showing snowfall from an event in 2019 covered by the National Weather Service Office at Buffalo, NY.

1. In what direction do we expect the winds to have been blowing towards during this event?

From the west to the east.

2. Mark on the plot the locations with the highest snowfall (in inches) seen in this plot. How much snow fell at these locations? (5 pts, 1.5 for each point, 2 for value)

More than 12-18 inches

3. Of what phenomenon is this event an example of? (5 pts)

Lake-effect snow

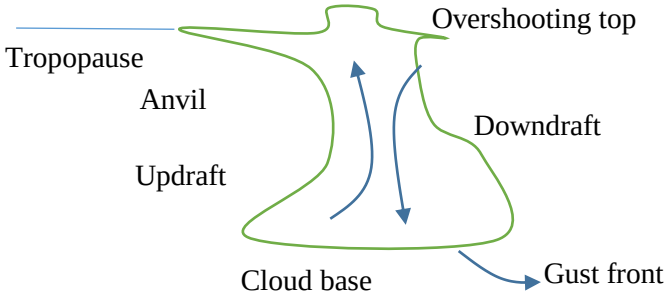
4. Meteorologists have suggested that decreasing ice over the Great Lakes might be associated with more snow in these regions. Describe how this might happen. (5 pts)

Less ice allows for more evaporation of water and the higher temperatures associated with less ice mean that the air can hold more water. Both of these effects would result in more snow (give credit for either)

Section A:___/20

B. Atmospheric physics

5. Draw a picture of a fully developed cumulonimbus cloud in cross-section, labeling the following components, cloud base, updraft, downdraft, anvil, overshooting top, tropopause, gust front. (8 pts, T1)



1 point for each component. 1 point for overall drawing

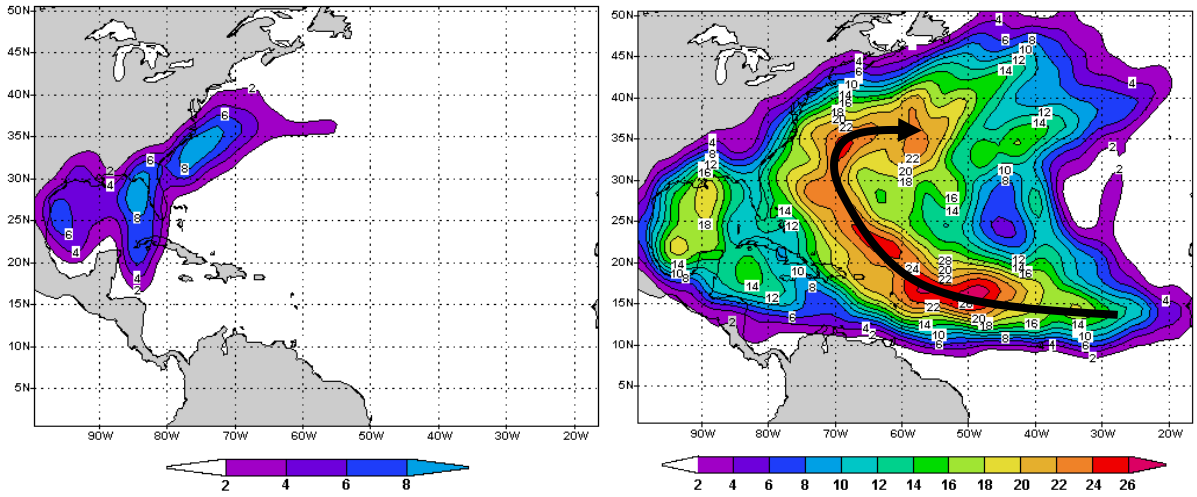
6. Describe the difference in the source of energy between a hurricane and a mid-latitude cyclone. (5 pts)

Hurricanes draw their energy from warm ocean water. Mid-latitude cyclones draw their energy from the contrast in temperature between the low and high latitudes (2.5 points for each one).

7. Katabatic winds are found at the edge of ice sheets. Why? (5 pts)

Air above ice sheets gets very cold. At the edge of the ice sheet this cold air (which is denser) flows down the sloping edge and forms very strong winds. (2.5 points each for the two key components, cold and a slope).

Section B:___/18



The plots above show the probability of a given point experiencing a tropical storm during the month of June (left) or September (right)

8. Describe the difference in the distribution between the two months. (5 pts)

In June tropical storms are limited to the Gulf of Mexico whereas in September they are found over a much broader area of the Atlantic (2.5 points)

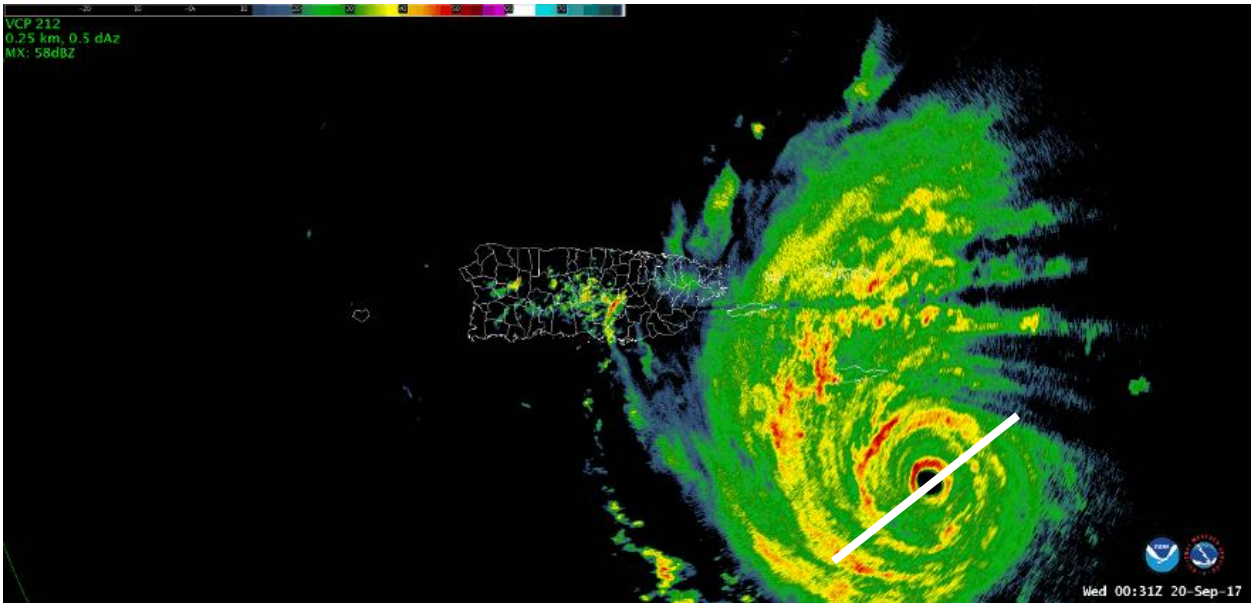
Tropical storms are much more likely to occur in September than in June (2.5 points)

9. Draw on the plot above an arrow showing the most probable track of a tropical cyclone. (5 pts)

See arrow on plot above.

10. Why are there no tropical cyclones as we move closer to the equator? (5 pts)

Near the equator the Coriolis force is weak, and so air flows into low pressure systems, damping them out. Away from the equator the Coriolis force is stronger and air flows around low pressure systems allowing them to organize and persist.



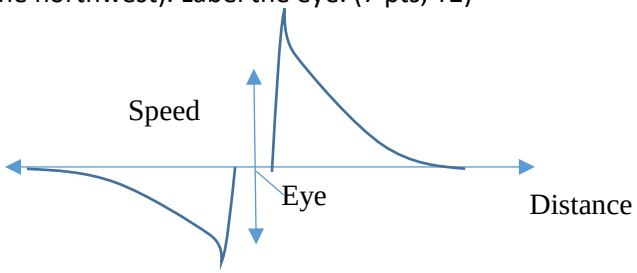
The plot above shows a Doppler radar image of a major hurricane that struck Puerto Rico in 2017, causing the deaths of upwards of 2000 people. The white line is a cross-section through this hurricane

11. What was the name of this hurricane? (5 pts)

Maria

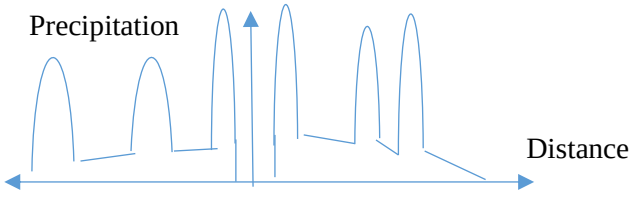
12. Draw a cross-section of the wind speed toward the northwest along the white line (assume that the hurricane is moving towards the northwest). Label the eye. (7 pts, T2)

1 pt each for labelled axes. 1 pt. for eye.2 pt for general shape. 2 pts for asymmetry



13. Draw a cross-section of the precipitation along the white line. (5 pts)

1 pt each for labelled axes. 2 points for getting three rainbands on each side.1 pt for getting right values between bands.



Section C:___/32

D: Definitions

14. Define the following terms (3 pts each)

a. Fujita scale: Intensity scale for destructiveness of a tornado- strongly related to windspeed.

b. Radiosonde: A balloon-launched instrument that measures the profile of winds, temperature and humidity in the atmosphere. (Used for determining potential for convection)

c. Barometer: An instrument that measures atmospheric pressure.

d. Relative humidity: The ratio between the amount of water a parcel of air holds the value it would hold if it were saturated with water (i.e. the amount it would hold if it were right next to a body of liquid water at the same temperature)

e. Dryline: An airmass boundary between moist and dry air (because moist air is lighter than dry air at the same temperatures, drylines are fronts in density and can produce thunderstorm systems).

f. Derecho: A high-wind event generally produced by a squall line in which the winds all blow in the same direction (contrast with tornado where they swirl)

g. Bow echo: A shaped echo seen in Doppler radar that is the signature of a gust front.

h. Mesoscale convective complex: An organized group of thunderstorms, usually with rotation, which can spawn tornados.

i. Saffir-Simpson scale: Scale of hurricane intensity based on wind speed.

j. Storm surge: Destructive rise of water pushed by hurricane winds and waves into the shore.

Section D: ___/30