PS : ES
Hurricane Sandy (October 2012)

Created by Z. Miller 2012

Name _____

Date _____

Per _____

Introduction: During the end of October 2012, Hurricane Sandy developed in the Caribbean region of the Atlantic Ocean Basin, and moved northward along the east coast of the United States. Like all tropical cyclones, this storm began with warm ocean water evaporating to produce water vapor-rich warm, moist, air (a Maritime Tropical, mT, air mass). As this same air moves up and away from the ocean surface (and, thereby, creating a low atmospheric pressure center, or "eye"), air from surrounding areas rushes inward in an attempt to fill the void. This inward air motion is responsible for the (often strong and damaging) winds associated with tropical storms and hurricanes. As Hurricane Sandy progressed northward (having started in the Southern Caribbean), this powerful tropical system devastated Cuba, Haiti, and ultimately, the Northeast United States. Hurricane Sandy, designated a "superstorm" as it combined and intensified with a cold front in the Northeast United States, has been attributed to at least 160 deaths in multiple countries, along with multiple billions of dollars in damage to our coastlines, homes, businesses, and infrastructure (i.e., roads, bridges, water supply, sewers, electrical grids, and telecommunications).

Your Task: Work to understand some of the details associated with this historic storm event in this activity.

1. On the accompanying map labeled Fig. 1 (see p. 4), plot the position of Superstorm Sandy at each of the 8 **bold** faced advisories in the data table (see p. 3). Label each point with the advisory number, and connect the points with a smooth line.

2. Considering either the black and white sea surface temperature (SST) map attached (p. 4), or the color SST map, describe (don't explain, yet) the differences in the sea surface temperature values of lower latitudes compared to that of higher latitudes? (*Remember: It's best to "Echo" the question in your answer. Hint: To do this, you may want to start your answer with, "The lower the latitude, …"*)

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3. From Dr. Jeff Masters' (an expert on tropical storms) website, wunderground.com, here is an excerpt from his Friday, November 26, 2012 blog post regarding then Hurricane Sandy (post can be found in full here: http://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=2276):

"During September 2012, ocean temperatures off the mid-Atlantic coast in the 5x10° latitude-longitude box between 35 - 40°N, 65 - 75° W were 2.3°F (1.3°C) above average, according to the UK Met Office. This is the 2nd greatest departure from average for ocean temperatures in this region since reliable ocean temperature measurements began over a century ago (all-time record: 2.0°C above average in September 1947.) These unusually warm waters have persisted into October, and will enable Sandy to pull more energy from the ocean than a typical October hurricane. The warm waters will also help increase Sandy's rains, since more water vapor will evaporate into the air from a warm ocean. I expect Sandy will dump the heaviest October rains on record over a large swath of the mid-Atlantic and New England."

4. On Monday, November 29, 2012, one of Jeff Masters' blog posts from that day read: (post can be found in full here: http://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=2280)

"Latest data from the Hurricane Hunters shows that Sandy is intensifying as its core traverses the warm waters of the Gulf Stream."

5. Considering your answer to #2, and the quotes shown in #3 and #4, write a short and clear summary as to why Hurricane Sandy showed little decrease in its intensity, and instead, generally maintained or strengthened its winds as it moved over open ocean waters parallel to the Southeast United States:

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6. In what general compass direction did Superstorm Sandy move between advisories 28 and 31? _____
7. Based on your answer to #4, what general wind direction was responsible for pushing Superstorm Sandy to the west starting at approximately advisory 28? _____
8. According to your Earth Science Reference Tables (ESRTs) p. 14, why is it generally unusual for a storm system to make this type of sharp turn to the northwest between 30° North Latitude and 60° North Latitude?

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9. On Fig. 2 (see p. 5), plot the position of Superstorm Sandy at advisories 30 and 31 only. Label each point with the advisory number, and connect the points with a smooth line. Label landfall by writing "LF" neatly where your smooth line between advisories 30 and 31 cross the New Jersey beaches.

10. Write a small "L" at each of these two advisories on Fig. 2.

11. Draw (4) short 3-cm lines with lines and arrows indicating the counterclockwise wind direction around the low pressure center (the "L") **at advisory 30**. This should be a summary of work you've already done on how air moves around a high- and low-pressure area.

12. Based on your wind direction arrows on Fig. 2, discuss why the *coastal* flooding — caused by what is named, "storm surge" — was worse in New York City and Northern New Jersey, compared to Norfolk, Virginia
(Note: Storm Surge is different than the amount of *inland* rainfall and flooding that occurred during the storm)

13. Write a brief reflection about your experiences with this historic storm. Try to incorporate an idea that you took away from completing this activity:

Date:	22-29	OCT	2012			
Hurricane	SANDY					
ADV	LAT	LON	TIME	WIND	PR	STAT
1	13.5	-78	10/22/15Z	25	1003	TROPICAL DEPRESSION
1A	13.5	-78.5	10/22/18Z	25	1003	TROPICAL DEPRESSION
2	12.5	-78.5	10/22/21Z	35	999	TROPICAL STORM
2A	12.7	-78.7	10/23/00Z	40	998	TROPICAL STORM
3	12.7	-78.6	10/23/03Z	40	998	TROPICAL STORM
3A	12.9	-78.7	10/23/06Z	40	998	TROPICAL STORM
4	13.3	-78.6	10/23/09Z	40	998	TROPICAL STORM
4A	13.4	-77.9	10/23/12Z	40	997	TROPICAL STORM
5	13.8	-77.8	10/23/15Z	45	993	TROPICAL STORM
5A	14.1	-77.6	10/23/18Z	45	993	TROPICAL STORM
6	14.3	-77.6	10/23/21Z	45	993	TROPICAL STORM
6A	14.8	-77.5	10/24/00Z	45	993	TROPICAL STORM
7	15.2	-77.2	10/24/03Z	50	989	TROPICAL STORM
7A	15.7	-77.1	10/24/06Z	55	988	TROPICAL STORM
8	16.3	-77	10/24/09Z	60	986	TROPICAL STORM
8A	16.6	-76.9	10/24/12Z	60	983	TROPICAL STORM
9	17.1	-76.7	10/24/15Z	70	973	HURRICANE-1
9A	17.6	-76.8	10/24/18Z	70	973	HURRICANE-1
10	18.3	-76.6	10/24/21Z	70	970	HURRICANE-1
10A	18.7	-76.4	10/25/00Z	75	968	HURRICANE-1
11	19.4	-76.3	10/25/03Z	80	954	HURRICANE-1
11A	20.1	-75.9	10/25/06Z	95	957	HURRICANE-2
12	20.9	-75.8	10/25/09Z	90	960	HURRICANE-2
12A	21.6	-75.5	10/25/12Z	90	967	HURRICANE-2
13	22.4	-75.5	10/25/15Z	90	964	HURRICANE-2
13A	23.5	-75.4	10/25/18Z	90	963	HURRICANE-2
14	24.5	-75.6	10/25/21Z	90	963	HURRICANE-2
14A	24.8	-75.8	10/26/00Z	85	965	HURRICANE-2
15	**25.3**	**-76.1**	**10/26/03Z**	**80**	**968**	**HURRICANE-1**
15A	25.8	-76.5	10/26/06Z	75	968	HURRICANE-1
16	26.3	-76.9	10/26/09Z	70	968	HURRICANE-1
16A	26.4	-76.9	10/26/12Z	70	970	HURRICANE-1
17	26.7	-76.9	10/26/15Z	70	970	HURRICANE-1
17A	27.1	-77.1	10/26/18Z	65	971	HURRICANE-1
18	27.3	-77.1	10/26/21Z	65	971	HURRICANE-1
18A	27.5	-77.2	10/27/00Z	65	970	HURRICANE-1
19	**27.7**	**-77.1**	**10/27/03Z**	**65**	**969**	**HURRICANE-1**
19A	28.1	-76.9	10/27/06Z	65	969	HURRICANE-1
20	28.6	-76.7	10/27/09Z	60	969	TROPICAL STORM
20A	28.8	-76.8	10/27/12Z	65	960	HURRICANE-1
21	29	-76	10/27/15Z	65	958	HURRICANE-1
21A	29.7	-75.6	10/27/18Z	65	961	HURRICANE-1
22	30.2	-75.2	10/27/21Z	65	961	HURRICANE-1
22A	30.5	-74.7	10/28/00Z	65	961	HURRICANE-1
23	**30.9**	**-74.3**	**10/28/03Z**	**65**	**960**	**HURRICANE-1**
23A	31.5	-73.7	10/28/06Z	65	960	HURRICANE-1
24	31.9	-73.3	10/28/09Z	65	960	HURRICANE-1
24A	32.1	-73.1	10/28/12Z	65	951	HURRICANE-1
25	32.5	-72.6	10/28/15Z	65	951	HURRICANE-1
25A	32.8	-71.9	10/28/18Z	65	951	HURRICANE-1
26	33.4	-71.3	10/28/21Z	65	952	HURRICANE-1
26A	34	-70.9	10/29/00Z	65	950	HURRICANE-1
27	**34.5**	**-70.5**	**10/29/03Z**	**65**	**950**	**HURRICANE-1**
27A	35.2	-70.5	10/29/06Z	65	950	HURRICANE-1
28	**35.9**	**-70.5**	**10/29/09Z**	**75**	**946**	**HURRICANE-1**
28A	36.8	-71.1	10/29/12Z	75	946	HURRICANE-1
29	**37.5**	**-71.5**	**10/29/15Z**	**80**	**943**	**HURRICANE-1**
29A	38.3	-73.1	10/29/18Z	80	940	HURRICANE-1
30	**38.8**	**-74.4**	**10/29/21Z**	**80**	**940**	**HURRICANE-1**
31	**39.8**	**-75.4**	**10/20/03Z**	**65**	**952**	**POST-TROPICAL CYCLONE**

Name _____

Per _____

Hurricane Sandy
Late-October, 2012

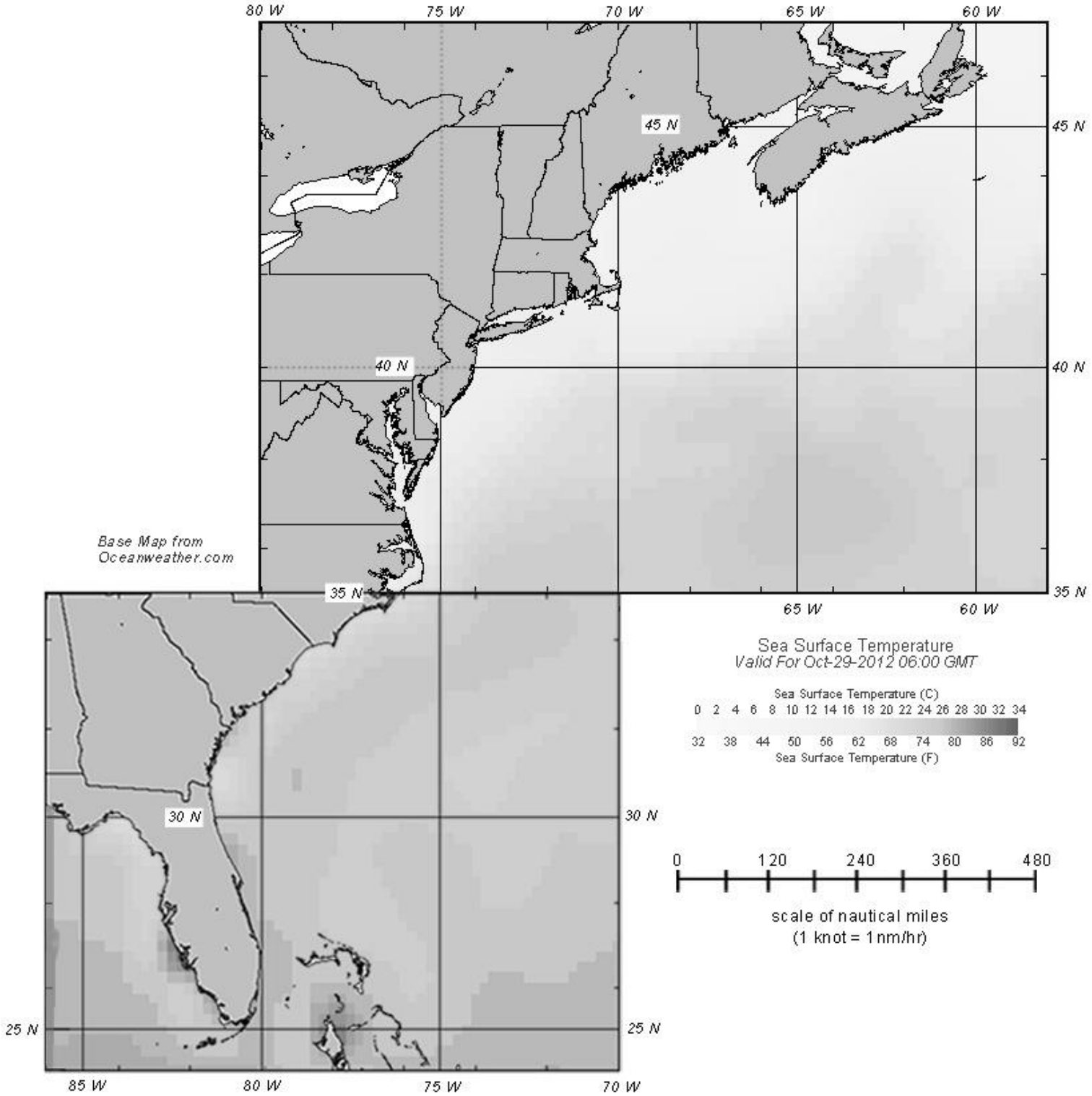

Fig. 1

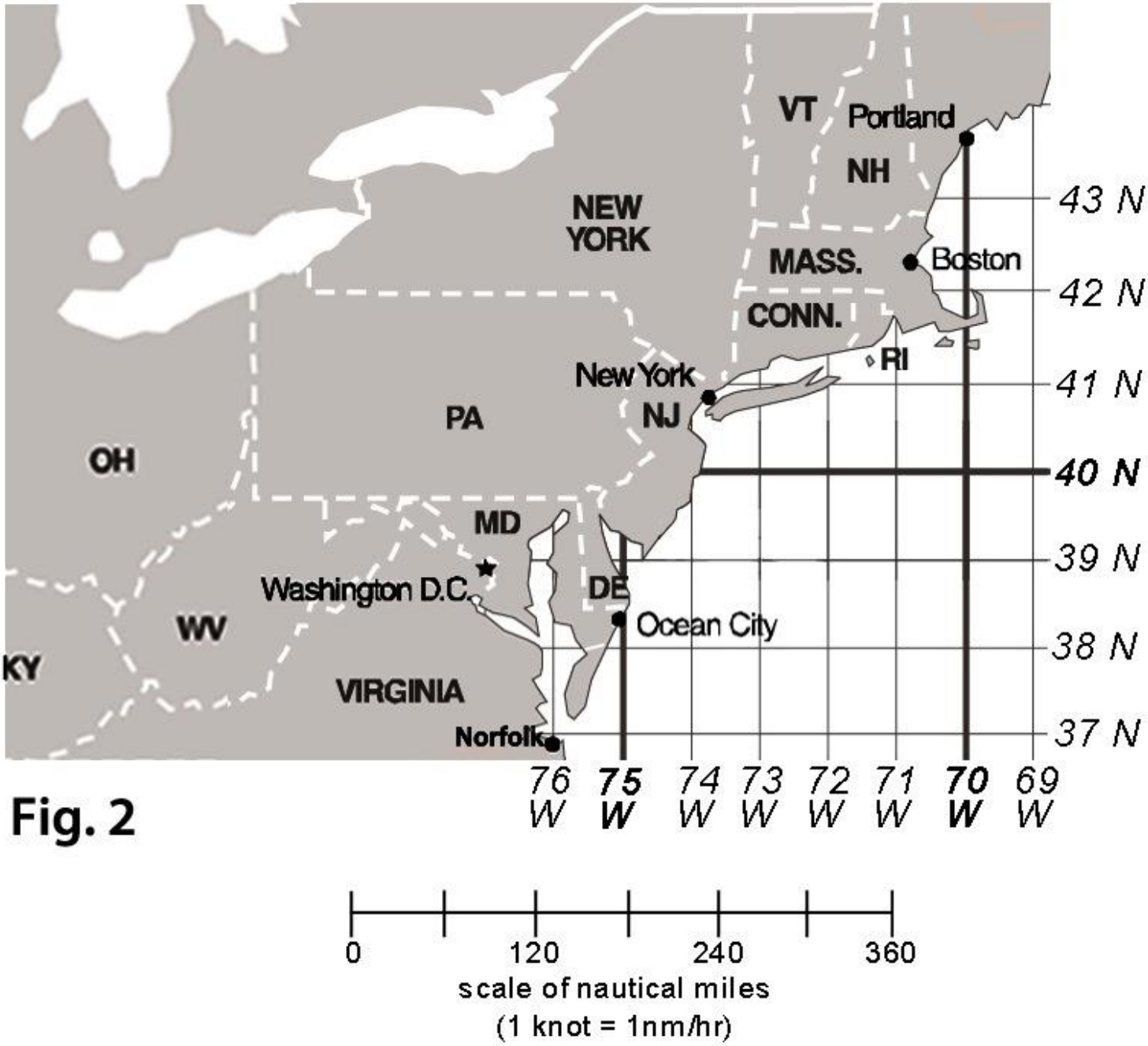
VT
Portland
NH
NEW YORK
MASS.
Boston
CONN.
RI
New York
NJ
PA
OH
MD
Washington D.C.
DE
Ocean City
WV
KY
VIRGINIA
Norfolk
43 N
42 N
41 N
40 N
39 N
38 N
37 N
76 W
75 W
74 W
73 W
72 W
71 W
70 W
69 W

Fig. 2

0
120
240
360
scale of nautical miles
(1 knot = 1nm/hr)