

Ocean Weather Worksheet

Description:

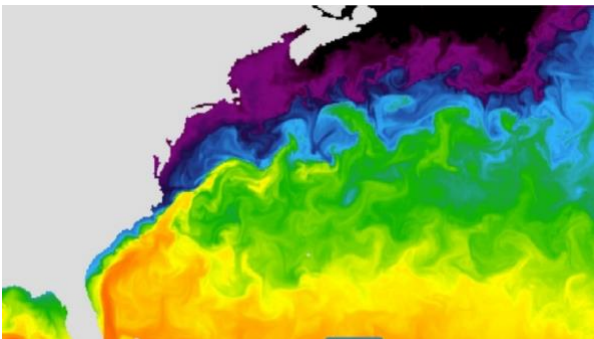
Ocean forecasts are like the atmospheric weather forecasts you see on the news. The ability to forecast conditions in the ocean is very important to a number of people (and animals). Oceanographers track and study ocean temperature for a number of reasons (global ocean temperatures, impacts on ocean life, prediction of ocean life, prediction of ocean currents, prediction of rip currents, prediction of storm event intensity), atmospheric scientists track and study the impact of the ocean on the air/sea interface, fisherman track ocean temperatures to figure out where to fish, and any person utilizing the ocean in any capacity monitors ocean surface temperature for a myriad of applications.

Part 1 – A good day for the beach?

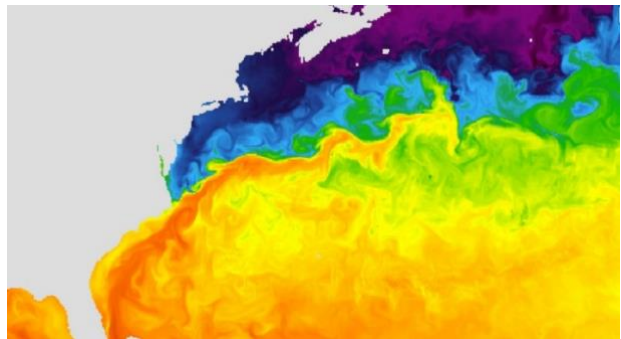
Materials:

- Copies of the Ocean Forecast Worksheet
- Access to real time data
- Full-circle or semicircular protractor
- Calculator (optional)

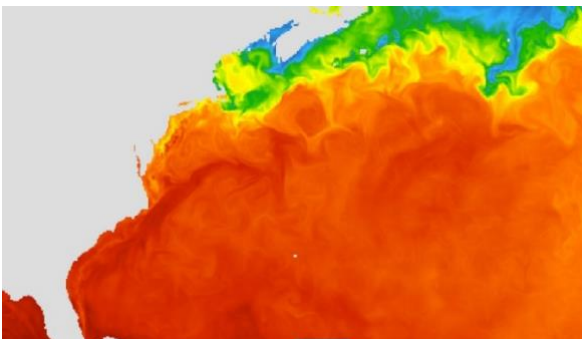
1) Differences in ocean water temperature are caused by the heat of the sun. The surface layer of the ocean is the warmest because it absorbs energy, or heat, from the sun. Most of the heat from the sun is absorbed by the water in the first 100 meters (325 feet) of the ocean. Below this depth, light and heat from the sun no longer penetrate, and the ocean becomes colder and darker as you go deeper. If you could dive down through the ocean with a thermometer, you would notice that the temperature at the surface is the warmest, followed by a thinner layer of water called the thermocline where the temperature rapidly decreases. Below the thermocline is a deeper layer of cold water where the temperature changes very little with depth all the way to the bottom.



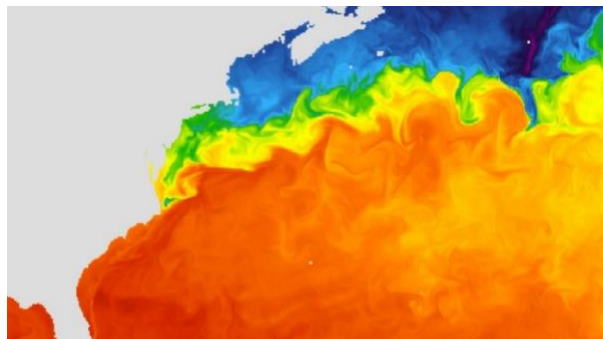
Winter



Spring



Summer



Autumn

Navy HYCOM Water Temperature Valid Time: Mar 7, 2019 16:00 (GMT -05:00)



Surface ocean temperatures change seasonally in most areas of the global ocean.

Above are images of surface temperatures in the Atlantic Ocean provided by the Navy's HYCOM model.

1a) Using the legend to the left, what is the temperature of the water off the new Jersey Coast during each season?

1b) Do these temperatures make sense to you? Explain.

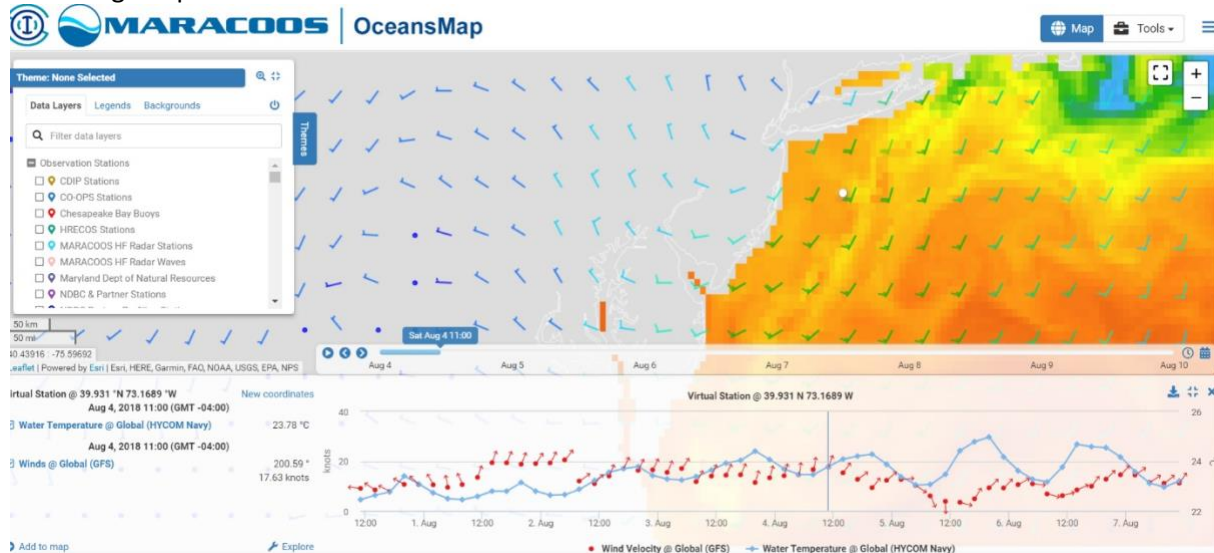
1c) Notice that the water temperature is warmer at the bottom right corner of all of the images. Can you think of a reason why this warmer water would be present further out in the ocean all through the year?

1d) Using the NOAA IOOS Data Portal (<http://oceansmap.maracoos.org/>), what is the ocean surface temperature off the New Jersey coast today?

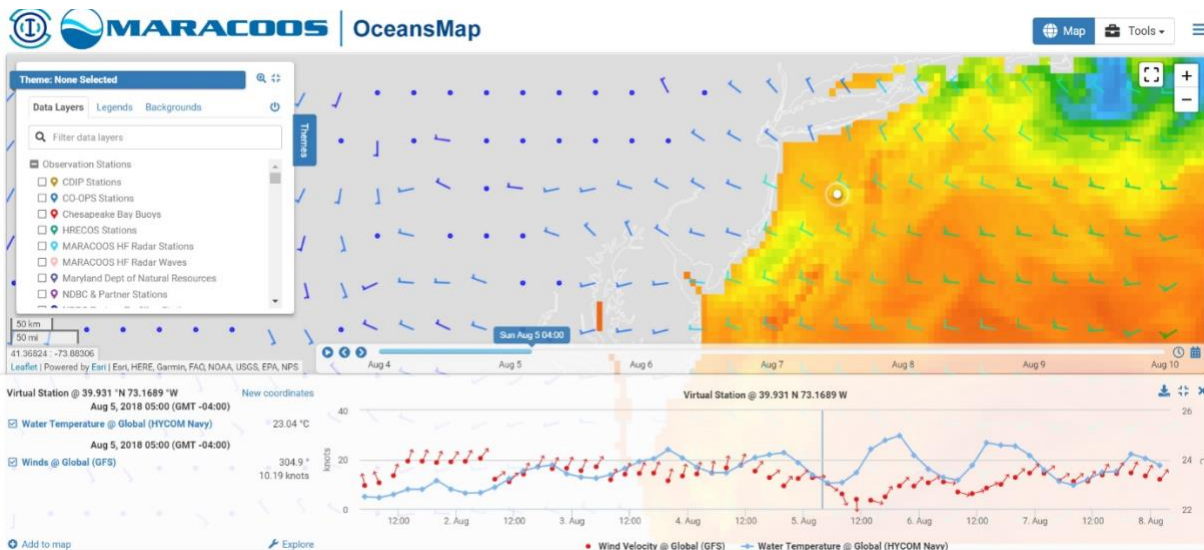
1e) What is the ocean bottom temperature off the New Jersey coast today? (select the Mid-Atlantic DOPPIO Bottom data layer).

1f) Using the time slider at the bottom of the screen, set the time frame from now, back one year. Using the slider, slide back in time. Does the bottom temperature change seasonally? Explain.

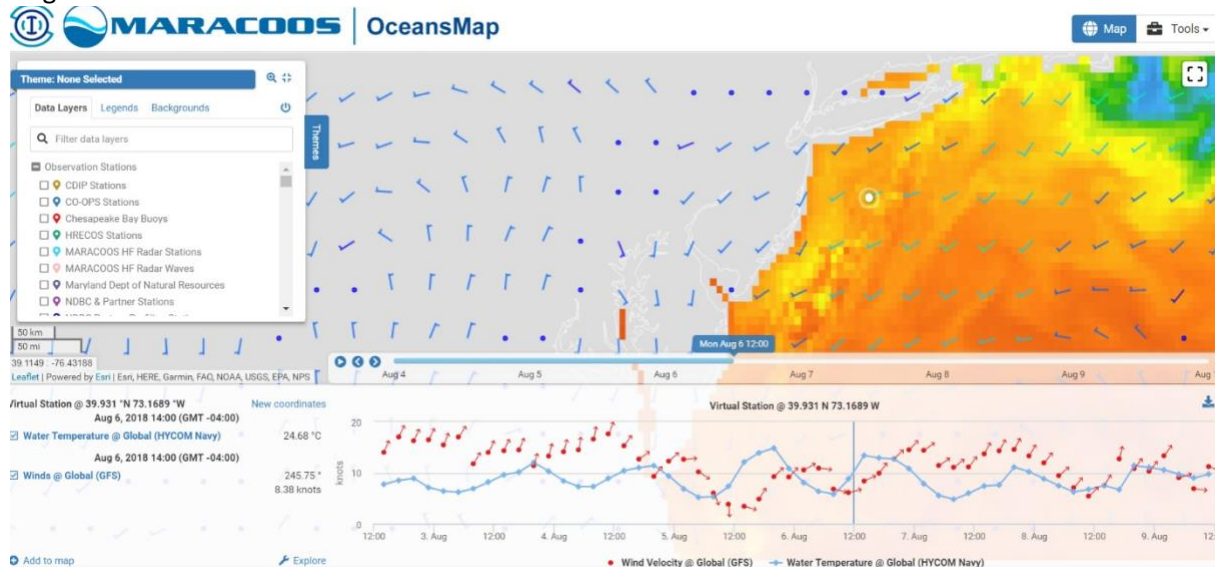
2) The ocean is in constant motion. Global ocean circulation is the large scale movement of waters in the ocean basins. Winds drive surface circulation, and the cooling and sinking of waters in the Polar Regions drive deep circulation. Surface circulation carries the warm upper waters poleward from the tropics. Ocean scientists need to know the direction and speed of the wind. The speed of the wind can have a large impact on the currents in the ocean.



August 4



August 5



August 6

Navy HYCOM Water Temperature
Valid Time: Mar 7, 2019 16:00 (GMT -05:00)



Above are images of surface temperatures in the Atlantic Ocean provided by the Navy's HYCOM model and the wind from Global (GFS) model.

2a) Using the legend to the left, what is the temperature of the water off the new Jersey Coast each day?

2b) Using the legend to the left, which direction is the wind blowing from each day?

2c) Do you see any differences in surface water temperature off the southern New Jersey coast? Explain.

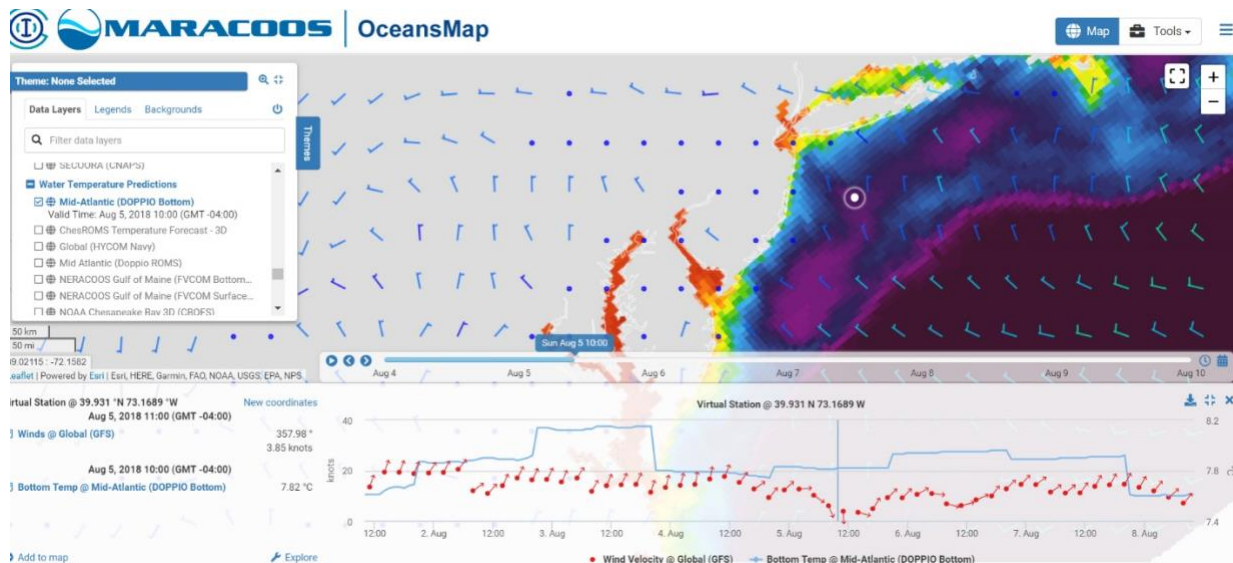
3) During summer months, coastal upwelling can have a major impact on the water conditions along the beach and in the coastal ocean. Coastal upwelling occurs when cold, nutrient-rich water moves up from the bottom layer of the ocean to the surface. This cold layer of water is usually too cold to swim in. So an upwelling day is a “bad” beach day. But it’s a good day for lots of marine life. As the cold bottom layer moves towards the surface, it carries an abundance of nutrients (“fish food”) with it. As these nutrients reach the surface, many fish come closer to shore to munch on all the goodies, therefore making it a “good” fishing day.

3a) Where did the colder patch of water on August 5th come from?

3b) Describe how winds are related to upwelling events off the coast of New Jersey.

3c) In your own words describe the how an upwelling happens along the coast of New Jersey.

3d) Explain how an upwelling can affect the food chain in the ocean.



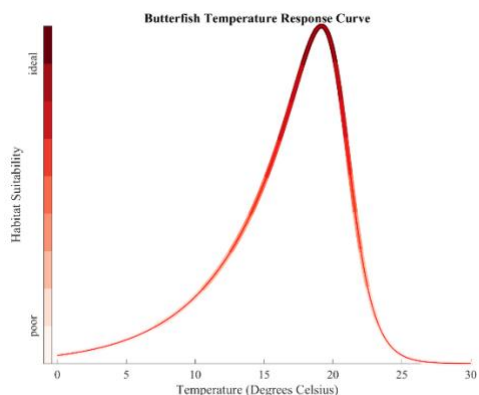
August 5 – bottom water temperature

The above image was captured from data collected on August 5th. To access this data set, select the Mid-Atlantic DOPPIO Bottom Temperature layer (<http://oceansmap.maracoos.org/#>) and set the date slider tool to range from August 4 – 7, 2018.

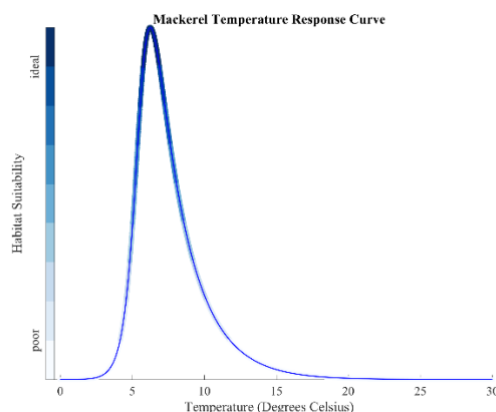
3e) Use the date slider tool to collect the bottom temperature data set for all of 2018. Slide it along and rest on arbitrary dates for a winter day, spring, summer and autumn day. How do the bottom temperatures compare with the surface temperatures in the previous section?

3f) Unselect the Mid-Atlantic DOPPIO Bottom Temperature Layer and re-select the HYCOM Model for surface temperature. The slider should remain with a year’s worth of data, if not, reset slider to display a year’s worth of sea surface temperature data. Again, slide thorough the year to see if you can identify another upwelling event.

3g) Who cares? Fish care. Many species of fish actually have rather narrow water temperature preferences and will migrate up and down the water column and within a region until they find sections of the ocean that are “just right”. Using the information provided below, and using the data available on the MARACOOS site, on March 15, would you be more likely to find Mackerel or Butterfish off the NJ coast? Explain.



Butterfish



Mackerel

<p>Location Ocean and brackish water. Depth range 15 - 420m usually around 55m.</p> <p>Distribution Western Atlantic: eastern Canada to Gulf Coasts of FL, USA.</p> <p>Biology Forms large schools over the continental shelf, except during the winter months when they tend to descend to deeper water.</p>	<p>Location Atlantic Mackerel</p> <p>Ocean, surface-dwelling. Overwinter in deeper waters but move closer to shore in spring.</p> <p>Distribution Northern Atlantic</p> <p>Biology Abundant in cold and temperate shelf areas, forms large schools near the surface. Mainly diurnal.</p>
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Part 2 – A bad day for the beach

Materials:

- Copies of the Ocean Forecast Worksheet
- Access to real time data

1) Tidal currents, created by the interactions of the Earth, sun, and moon, are affected by the different phases of the moon. The vertical motion of the tides near the shore causes the water to move horizontally, creating currents.

Local surface currents move water along the coast. The two types of coastal surface currents are long shore currents and rip currents. When a wave reaches a beach or coastline, it releases a burst of energy that generates a current, which runs parallel to the shoreline. This type of current is called a longshore current. Rip currents are potentially dangerous currents that carry large amounts of water offshore quickly. A rip current is a localized current that flows away from the shoreline toward the ocean,

perpendicular or at an acute angle to the shoreline. It usually breaks up not far from shore and is generally not more than 25 meters (80 feet) wide.

How do rip currents form? Rip currents are formed when waves break near the shoreline, piling up water between the breaking waves and the beach. One of the ways that this water returns to sea is to form a rip current, a narrow jet of water moving swiftly away from shore, roughly perpendicular to the shoreline.



How big are rip currents? Rip currents can be as narrow as 10 or 20 feet in width though some may be up to 10 times wider. The length of the rip current also varies. Rip currents begin to slow down as they move offshore, beyond the breaking waves, but sometimes extend for hundreds of feet beyond the surf zone.

The primary factors considered in a rip current forecast process include:

- wave height and direction
- prevailing wind speed and direction
- percentage of wind observations directed onshore within the previous 48-hour period
- tides focused around a new or full moon, and
- recent rip current reports from lifeguards.

Using the factors listed above, the National Weather Service produces a Rip Current Forecast for many segments of the coast in the U.S.

(The Surf/Ripcurrent forecast starts May 20, 2016 and ends September 30, 2016)



New Jersey Rip Current Seasonal Forecast (<https://www.weather.gov/phi/surfrip4>)

What is the risk of a rip current today along the NJ Shore?

The **green line** represents low risk- the surf zone conditions are not expected to generate life threatening rip currents.

The **yellow line** shows where the surf zone conditions are favorable for generating life threatening rip currents.

The **red** indicates high risk where the surf zone conditions will likely generate life threatening rip currents.

The addition of HF radar to the forecasting of rip currents is currently being sorted out and will be added to MARACOOS OceanMap in the near future.

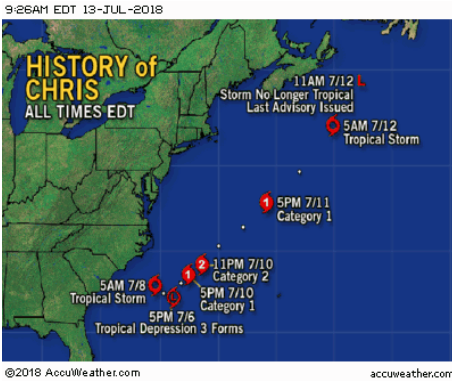
2) While rip currents are fairly frequent occurrences, larger coastal impacts of large storms and hurricanes can not only trigger more intense rip currents, but much more damage.

Do you know how a hurricane forms? View Hurricane Formation ppt if needed. As often as they seemingly occur during hurricane season, the conditions needed are specific for formation, duration and intensity.

Access the MARACOOS OceansMap (<http://oceansmap.maracoos.org/#>) and set the time slider from July 4 – 12, 2018. Select the following data layers:

- HYCOM water temperature
- Global GFS (wind)
- Mount Holly/Philadelphia CG1
- CO-OPS Stations

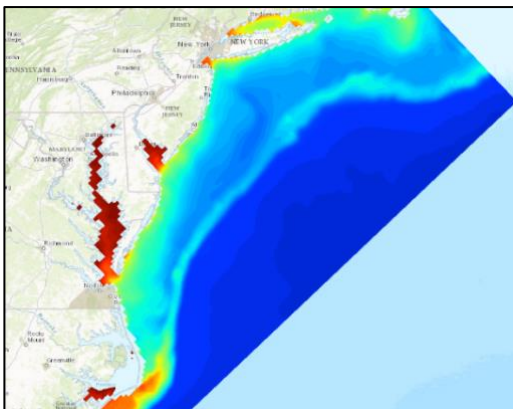
2a) Scroll through the days and focus on the water off the New Jersey Coast. What do you notice about the parameters selected? Water temperature, winds, etc?



While offshore, Hurricane Chris brought large swells to the East Coast of the United States, sparking hundreds of water rescues especially along the coasts of North Carolina, New Jersey, and Maryland.

2b) Now layer on Gliders and IOOS National HF Radar 6km. With all the layers, the HF Radar arrows will be difficult to see, you may need to zoom into the New Jersey coast area using the + button in the top right. What trends emerge from the data?

3) Hurricane Chris stayed well off shore, however still generated large coastal waves. What happens when hurricanes are much closer to shore? Well, with all these new data available, something very interesting emerged. Remember selecting the bottom water temperature layer in earlier examples? The bottom layer becomes a very important character in the story of Irene and Sandy.



Bottom temperature

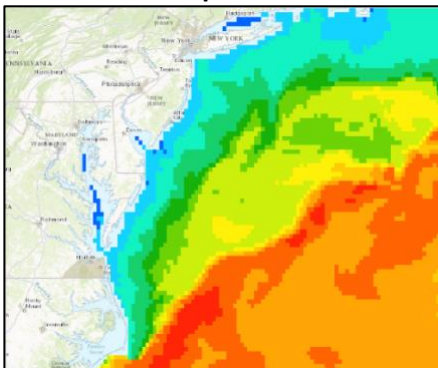
The addition of MARACOOS data into storm intensity predictions is important to assist in better local forecasts and add to better overall storm prediction.

Currently, forecasting models are created with deep ocean parameters-not coastal ocean-so as the storm nears the coast, storm intensity model is skewed.

In particular we need to be able to predict the ocean temperature to understand how the ocean might impact the intensity of an approaching storm.

Winter

Sea Surface Temperature



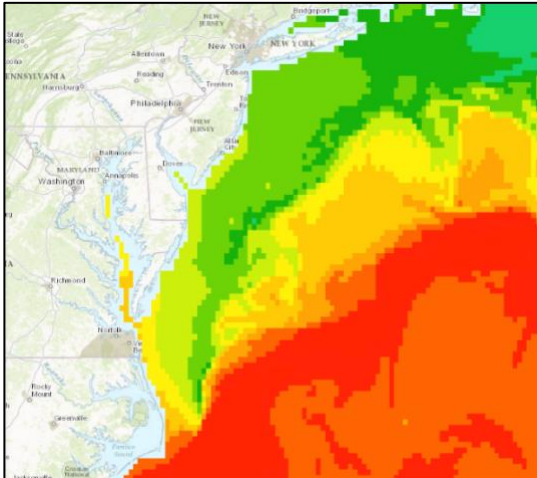
Bottom Temperature



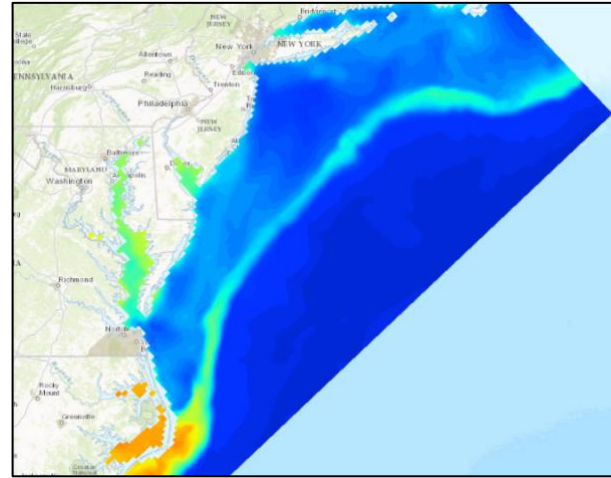
There is little difference between surface and bottom temperatures during the winter so storms will not intensify from heat and moisture added from the ocean surface as the storm passes over.

Spring

Sea surface temperature



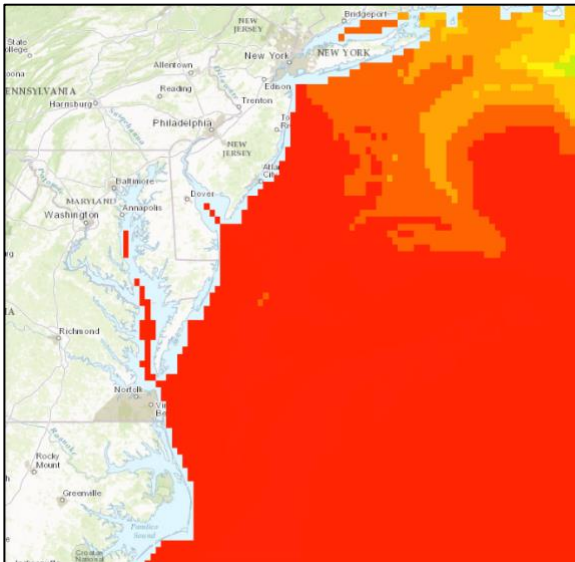
Bottom temperature



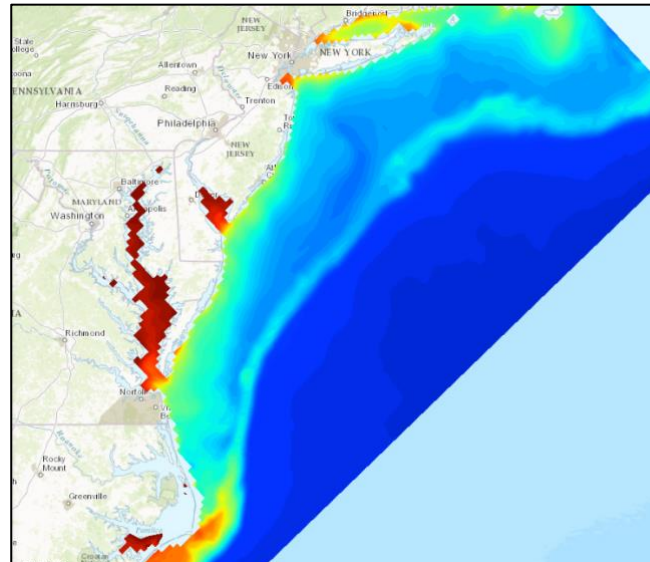
While the ocean surface is warming during the spring, the difference between surface and bottom temperature is not significant so storms will not intensify from addition heat and moisture added from the ocean surface as the storm passes over.

Summer

Sea surface temperature



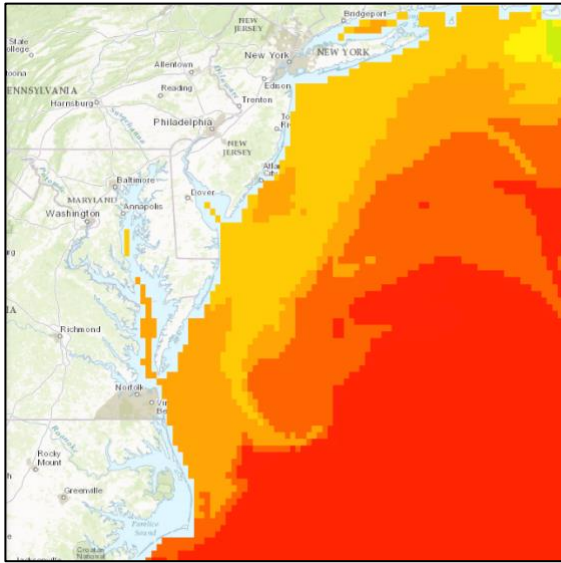
Bottom temperature



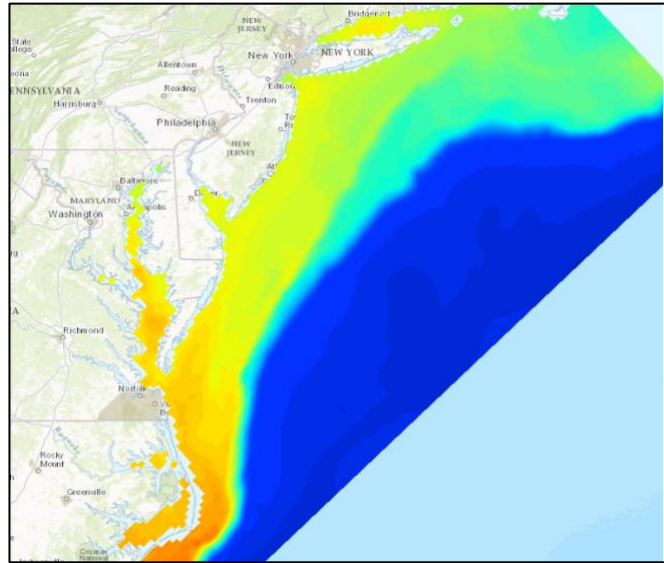
The temperature difference between surface and bottom can be quite significant during the summer. Storms mixing the water layers can pull cooler water up from the bottom, cutting off “fuel” to the storm can contribute to de-intensifying the storm as it passes over the coastal region, acting as a “fire extinguisher.”

Autumn

Sea surface temperature



Bottom temperature

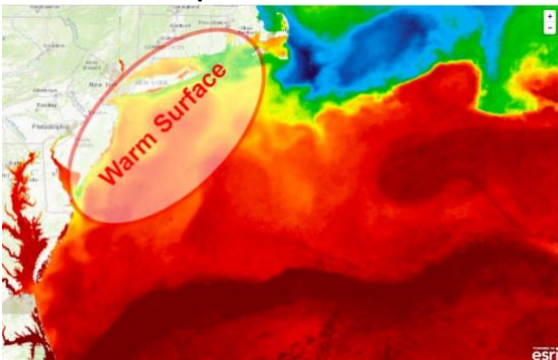


The temperature difference between surface and bottom can be similar and warm during the autumn, therefore late season tropical cyclones can be especially dangerous because the “fire extinguisher” mechanism is no longer in place.

This “fire extinguisher” effect is clearly displayed in the Irene versus Sandy story.

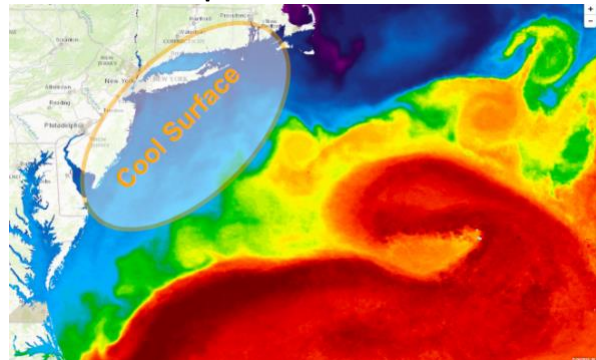
Irene (August 21 -28, 2011)

Sea surface temperature

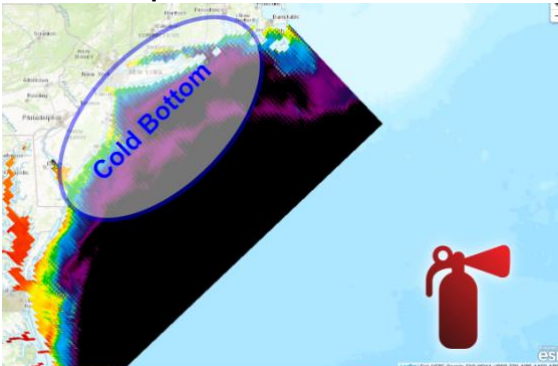


Sandy (October 22 – November 2, 2012)

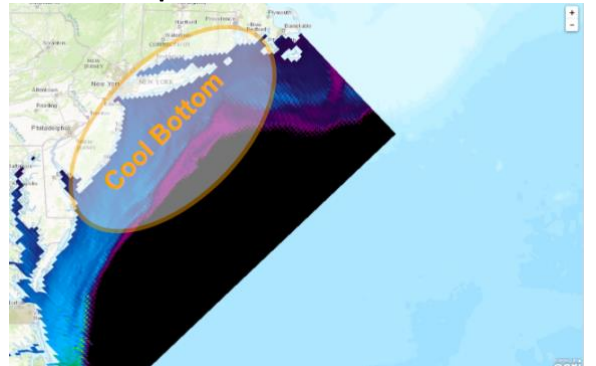
Sea surface temperature



Bottom temperature



Bottom temperature



3a) As an impact of climate change, ocean sea surface temperatures are trending upward. What impact might that have on increased frequency of late hurricane season storms?

4) Access the MARACOOS OceansMap (<http://oceansmap.maracoos.org/#>), reset the time slider to 5 days prior until today. Given all the previous examples:

4a) Do you think there will be an upwelling event tomorrow? Explain and describe the data layers selected to make your decision.

4b) Do you think there will be a large ocean storm event tomorrow? Explain and describe the data layers selected to make your decision.

4c) Do you think it will be a good day to go to the beach tomorrow? Explain and describe the data layers selected to make your decision.

Resources

Meteorologist

<https://www.ametsoc.org/ams/index.cfm/education-careers/career-guides-tools/all-about-careers-in-meteorology/>

Oceanographer

<https://www.environmentalscience.org/career/oceanographer>