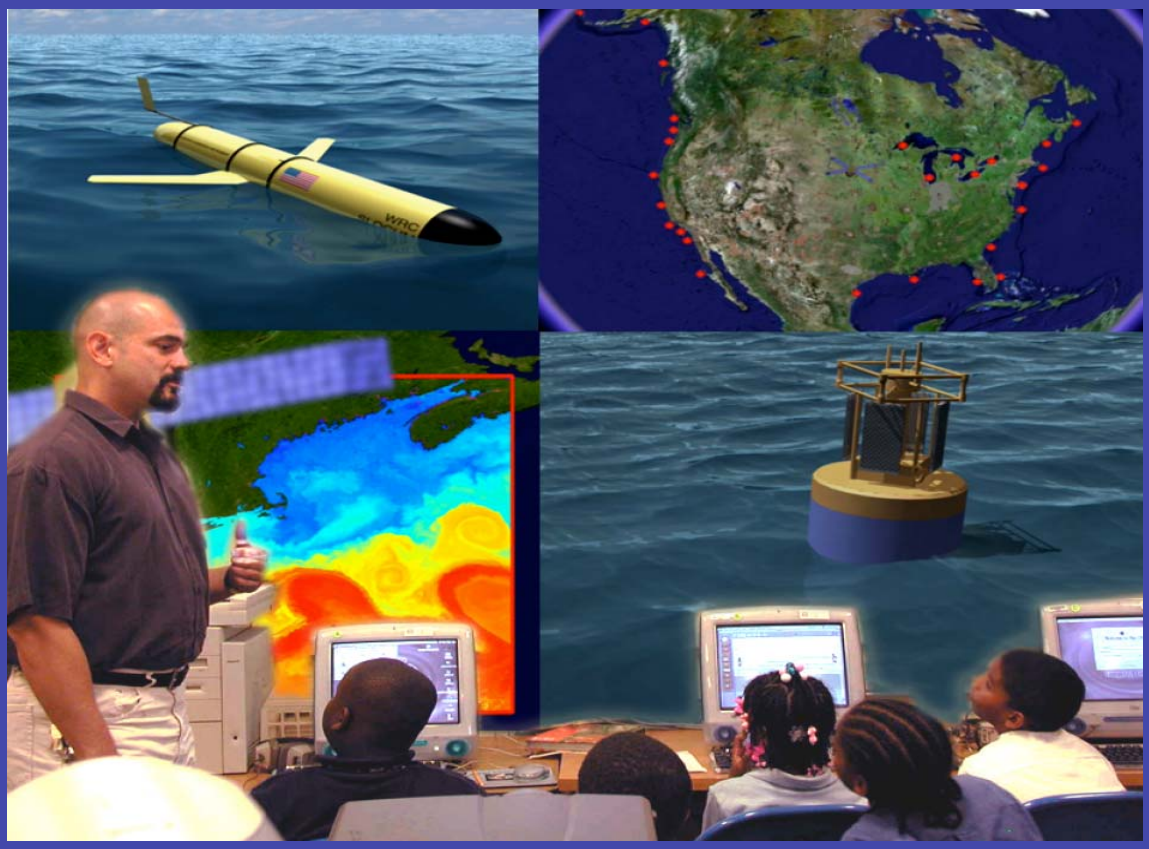
RUTGERS

Having Fun with Data: Using COOL Data for Education & Public Outreach (EPO)



Janice McDonnell

Rutgers University

Institute of Marine & Coastal Sciences

Email: mcdonnel@marine.rutgers.edu

Phone: (732) 932 6555 x521

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Jacques Cousteau
National Estuarine Research Reserve

RTD Activity Idea #1 – Christmas Island

December 15, 2006

When we think of the holidays, perhaps the last thing that comes to mind is real-time data. But the truth is, the holidays are filled with data. Here are just a few data questions you might pose to yourself this year:

- Is my flight on time?
- How many holiday cards will I receive or send this year?
- When will my package arrive? And why the heck is it stuck in Knoxville?
- And perhaps most asked of all: Will it be a white Christmas?

The fact is, the holidays are filled with data, real-time and otherwise, and no where is this more apparnet than in the retail industry. Store managers and company executives follow their sales data closely, analyzing year-to-year results and looking for trends, trying to devise ways (i.e. through the use of coupons, sales and last-minute deals) to entice as many customers as possible to hopefully increase their profits.

But of course, retailers don't publicize their data, so we can't use it in the classroom. Our budding future marketers and sales reps will have to wait. In the meantime, they'll have to play with datasets that some might consider more fun anyway, that is, data from the environment.

But it is possible to celebrate the holidays using real-time environmental data? Well, to prove it can be done, here's one quick idea that also has wonderful history and geography tie-ins.

Christmas Island (or more correctly called Kiritimati) lies near the Equator in the middle of the Pacific Ocean. It was discovered in 1777 on Christmas Eve (go figure) by none other than Captain James Cook. The Island served as a weather station and rest stop for planes traveling to the South Pacific during World War II and was the site of several nuclear bomb tests during the 1960's. Not only is the Island named for the Christmas holiday, but an adjustment to the International Date Line in 1995 means the island is now the first inhabited place on Earth to bring in the New Year.

A) Real-time Data Project

For those of us who live in the Northern Hemisphere, particularly above 30N, we tend to associate Christmas with winter and cold weather. Of course, for the Southern Hemisphere, December 22 will be the first day of Summer, and for those who live along the Equator, well... they won't notice much of a change in seasons at all. A great way to emphasize the variability of seasons over the globe is to study real-time weather data or archived climate averages.

As it turns out, the National Weather Service maintains a weather buoy off the coast of Christmas Island.
http://ndbc.noaa.gov/station_page.php?station=51028

For a quick activity, students can compare real-time weather data (i.e. air & water temperatures, wind speeds and presure) from Christmas Island with a second buoy closer to them. As an extension, students can choose several buoys from across the globe, looking at the differences in real-time data between each, while trying to describe why those differences exist. A full listing of real-time buoys can be found here:
http://ndbc.noaa.gov/rmd.shtml

If you wish to delve further, one of the nice features about the NDBC Buoy site is that on the bottom of each buoy's page you can find a link to "Historical Data & Climatic Summaries." From here, you have quick access to historical data files that you can quickly load into Excel and plot.

More importantly, also available on these pages are "Climatic summary plots" for each buoy, which are pre-made box plots that show monthly averages of each meteorological variable. For studying the seasonal variability of temperature, winds and waves at each station, these plots are perfect starting points. They're also useful for easily putting real-time values within their climatic context.

B) Engaging Questions

Here are a few questions students can think about before they start their research.

- What temperature do you think the atmosphere and ocean's surface are this time of year 1) near here and 2) along the equator?
- Why does the Weather Service have a buoy in the middle of the Pacific Ocean?
- How many people live on Christmas Island? What is the population density? How do they get their food and water?
- Do seasons vary in different parts of the world?

C) Suggested Research Questions

- What is the current temperature of the air and ocean near Christmas Island? How does that compare with where we are?
- Has the temperature or winds changed at all during the past week?
- What does the seasonal cycle of temperature, winds and waves look like? What factors might cause this annual pattern?
- Do the current conditions differ much from those expected from the climatic averages?
- Compare the annual patterns in the measured data (temperature, winds, etc.) between two or more buoys in different locations. What differences are there between the plots, and what factors might cause those differences?

D) Relevant References

Wikipedia entry on Kiritimati (Christmas) Island
http://en.wikipedia.org/wiki/Kiritimati

Data Tips #2 and #3 on the site below contain more information on using climate and ocean data for student research projects.
http://marine.rutgers.edu/outreach/urbanadvantage/

If you already discuss El Nino in your lessons, you can also point out that the Christmas Island buoy is right in the middle of the TAO observing array which is used to monitor El Nino conditions. There's a wealth of information on the net about El Nino, and here is just one page of educational resources.
http://www.cdc.noaa.gov/ENSO/enso.education.html

If you have any thoughts or suggestions on how to make this activity better, please share. I'd also especially like to here from any of you that use some of these ideas with your classes.

Happy Holidays,

Sage Lichtenwalner

Institute of Marine and Coastal Sciences
Rutgers, The State University of New Jersey
71 Dudley Road, New Brunswick, NJ 08901
Phone: (732) 932-6555 x533
Email: sage@marine.rutgers.edu

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RTD Activity Idea #2 – White Christmas

December 18, 2006

This time of year, meteorologists across the country are being asked "Will we have a White Christmas this year?" And I bet even those of you who are known as Earth/Environmental Science teachers to your friends and family are being asked the same question.

Such is the life of those us "in the know," who understand, at least to a small extent, how to interpret weather data and can understand what that data tells us about Earth's complex systems. Everyone expects us to know everything about the weather. So here's some inside information to help you out when you're asked.

Unfortunately, for those of us who enjoy waking up Christmas morning to find snowflakes gently falling towards the Earth and all the evergreen trees covered in a bright blanket of freshly fallen snow, this year's long-range outlook doesn't look too promising for most of the country. Indeed, for most of us it's been several degrees warmer than normal. On the other hand, this is probably good news for those who are traveling this holiday to see friends and family.

Either way, the question of how "probable" a White Christmas is for any given city from year to year is still a fun data exercise to explore, and it doesn't have to take a lot of time either.

A) Looking Back: The Probability of Snow

When meteorologists develop their predictions on the weather, they always start with climatology, that is, the average weather condition expected based on many years of observations. They will then alter their forecast based on short term processes like front locations and cloud formations, which affect the weather in the near-term from that expected based on climatology alone.

Unfortunately, it is hard to make short term predictions more than a week or two out, since fronts and clouds are highly variable. So, when predicting whether or not it will snow on any given day, the best guess one can make far out in advance it to look at climatic predictions and make a "best guess" of what to expect. Of course, the end result is that it either snows or it doesn't, and a probability map only tells us, say, how many years out of 30 one can expect to see snow on the ground. But such is the nature of weather forecasting. Closer to an actual date, when one knows the local temperature trends and locations of nearby weather systems, a more precise prediction be made.

But back to our White Christmas question, a few years ago the National Weather Service created several maps depicting the probability of snow on the ground (in

increments of 1 inch, 5 inches and 10 inches) on Christmas morning. You can find these maps and a nice summary in NOAA Magazine.
http://www.magazine.noaa.gov/stories/mag156.htm

At the very least, these maps would probably be fun to share with your students as a quick activity, in which you can ask them to find their hometown and determine how often they can expect a White Christmas in their future. You can also ask where they need to go in order to ensure they wake up to one, or on the other hand, where you need to go to ensure you don't.

Suggested Research Questions

- Based on your memory (or ask your parents), can you remember how many times you woke up on Christmas morning to find snow outside? Compare your memory to the probability found for your hometown on the map.
- Find the probability of snowfall for your hometown and the hometowns of any family friends or relatives that live out of state? Are they different?
- Compare the snow probability maps to a national map of elevation/topography. Do you notice any correlations?
- Can you explain the patterns of higher/lower snow probabilities? Is there a constant north/south relationship? Does proximity to the ocean play a role? What about elevation?
- Define what you think the probability numbers shown on these maps actually mean.

B) Looking Forward: Forecasting Snowfall

Thanks to many major advances in technology, we are able to observe and forecast the weather better than ever before. Today's weather models are fairly accurate at predicting conditions up to a week out, though forecasters still have trouble with large storms like blizzards and hurricanes after a couple days.

When it comes to predicting snowfall, the National Operational Hydrologic Remote Sensing Center, has some wonderful real-time datasets to play with.

National Snow Analyses http://www.nohrsc.noaa.gov/nsa/
This page contains neat images on recent snowfall and ground snow cover. The animations are particularly interesting, because you can observe recent snow storms as they cross the US. At the bottom of the page is a written snowfall forecast which is updated daily.

3D Snow Analysis http://www.nohrsc.noaa.gov/earth/
For those of you who like to use Google Earth in your classroom, this page features national real-time snow-fall images you can import into Google Earth to play around with. Also available are snowfall station reports which link back to dynamic time-series plots for each station.

Satellite Snow Cover Observations http://www.nohrsc.noaa.gov/nh_snow-cover/
On this page, you can access recent maps of snow cover across the US and even the northern hemisphere.

Snow Pictures http://www.nohrsc.noaa.gov/snowsurvey/photos/index.html

You can find cool images from around the country of snow and its impact on rivers and streams.

Forecasts http://www.nohrsc.noaa.gov/forecasts/
Finally, on this page, students can access forecast maps of weather fronts (up to 6 days out) and snowfall probabilities (up to 3 days out). In a few days, forecasts for 12/25 will become available.

Suggested Research Questions

- Describe the current pattern of snow cover in North America. What factors might explain the patterns you see?
- Has the snow cover pattern changed at all in the last week? Why may have caused these changes?
- Is there a relationship between this week's snow cover and the climatic probability map of a White Christmas? Describe why you think there might be differences between the two.
- How does snow impact rivers and lakes?
- After analyzing all of the snowfall forecast maps, can you make a prediction on whether it will snow soon in your state and if so, how much?
- Is there a relationship between weather fronts and snow fall?

C) Relevant References

A quick web search revealed the following additional White Christmas activity. It involves mapping out the probability of snowfall for several cities and then drawing contour lines. It is well suited for those of you who would like to work further on graphing and mapping skills. http://www.educationworld.com/a_lesson/02/lp290-05.shtml

If you live in the Northeast, and especially in the Mid-Atlantic, you might be interested in the 3-day weather forecast animations we produce for research purposes in the Rutgers COOLroom. http://marine.rutgers.edu/cool/weather/WRF/

And, the NWS Graphical Forecasts page has some great images of future weather conditions. Be sure to check out "Snow Amount" which shows detailed snowfall maps for 3-days, and also "Weather" which shows potential areas of rain & snow up to a week out. http://www.weather.gov/forecasts/graphical/sectors/conusLoop.php

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Jacques Cousteau
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RTD Activity Idea #3 – Robots in Antarctica

January 10, 2007

This past weekend, something "cool" happened in the COOLroom. That's cool as in cold. Antarctica cold! So I thought I'd share this quick activity with you all, in case you would like to incorporate some "really cool" real-time data from 65 degrees South latitude into your lessons on climate (and climate change), icebergs, biomes, marine biology or even the seasons (it's summer down there right now). Then again, you really don't need an excuse to tell this story. A little bit of oceanographic history is being made right now, and you and your students can follow along!

Scientists here at Rutgers are trying to stretch the limits that ocean technologies can go, in an effort to observe and monitor the ocean as never before. One of their most innovative gadgets is a remotely-controlled underwater robotic glider, which can swim up-and-down through the top 300 feet of the ocean for over a month at a time, all on its own. On each dive, it collects data on temperature, salinity, chlorophyll and more while it "glides" through the ocean. Every few hours, the glider surfaces, sticks it's tail fin above the water, and makes a satellite phone call back to the COOLroom in New Jersey. During the call, the glider can receive new instructions from mission controllers, or if it doesn't get any new directions, it will continue on its existing mission. It then transmits its recently collected instrument data back to the lab, where computer scripts process the data and make it available to the world.

Rutgers now has a fleet of over a dozen gliders and they have been flown in places like Hawaii, California, the Mediterranean, Liverpool, Florida, and extensively off the coast of New Jersey. In fact, this past summer we had a team of 6 gliders simultaneously patrolling the Mid-Atlantic continental shelf as part of a large research experiment.

But there's a lot more ocean out there to study. And this week, a glider was deployed off the coast of Antarctica, in an environment like none other we've flown in before.

Antarctica is a cold, stormy and harsh environment to work in, and that's on a nice day in the summer. It's also one of the last pristine areas on the planet, with very little human impact, but it is also viewed as one of the first places where changes in climate will, and in fact are, being seen. So scientists are trying to study the area as much as they can in order to see what changes are already occurring. It

is not cheap to do research there and so new ways to efficiently monitor the the ocean and environment are needed. Robotic underwater gliders present a viable option, and this month's glider demonstration hopes to show that they are up to the task.

A) Real-time Data Project

Real-time underwater data from our glider in Antarctica can be found found on the following page. http://marine.rutgers.edu/cool/auvs/?page=deployments

If all goes well, we hope to have a glider in the water collecting data for the rest of the month of January. If something goes wrong, that's okay to, because the purpose of this mission is to test the glider's capabilities in the harsh environment of the Southern Ocean. And since we've already collected at least a few days of data for scientists to work with, this mission of exploration is already a success.

Some notes on the data: You can select different "transects" (broken-up segments of data) using the pull-down bar. The most interesting plots for students are probably 1) temperature, 2) salinity, 3) density, 4) chlorophyll and 5) the transect map. Note that the profile plots of data correspond to slices of the ocean underneath the line shown on the transect map starting from the green circle and heading towards the red circle.

If you like to use Google Earth, we also have a kml file which includes the glider's path, current location, and way-point. By refreshing the link every few hours, you can update the latest position information. (You may need to save the file to your desktop first.) http://marine.rutgers.edu/~kerfoot/glider_portal/google_earth/active/

I've also posted some additional pictures from the deployment. They're very cool. http://marine.rutgers.edu/~sage/Antarctica/Antarctica.html

While planning for this mission, engineers were quite concerned about how sea ice and icebergs, which are typically prevalent in the area, might affect the glider by keeping it from reaching the surface, or in the worst case scenario, sink it. Imagine their surprise when they reached the station to find very little ice in the area! (You can compare the images taken during the deployment above with other images of Palmer Station in the summer found on the web to see a difference.)

B) Engaging Questions

Here are a few questions students can think about before they start their research. Wikipedia is a great place to find, somewhat reputable, background information.

- Why are Antarctica and the Southern Ocean important places for scientists to study?
- How will climate change affect Antarctica?
- Who were some of the first Antarctic explorers?
- How do scientists get to and live in Antarctica? What kinds of research do they do?

C) Suggested Research Questions

- Compare the chlorophyll plots with those of temperature and salinity. Do you see any relationships between them?
- At what depths are the maximum chlorophyll values in the profiles observed? What factors might explain this position?

- How far away is the glider from your current position? (You can use the measure tool in Google Earth.)
- Analyze the temperature plots, and convert the temperature scale to Fahrenheit if necessary. What is the difference in temperature and salinity from the water's surface, to the bottom of the measured profile? Is this a large difference? What impact do temperature and salinity have on density?
- Do you notice any temperature values that you don't expect (i.e. negative values)? How is this possible?

D) Relevant References

Here are a bunch of recent articles about the glider deployment in Antarctica.

Jan 8 - The little robot submersible that could (Philadelphia Inquirer)
http://www.philly.com/mld/inquirer/16406869.htm

Jan 9 - Mission on ice, briefly: Robot springs a leak (Philadelphia Inquirer)
http://www.philly.com/mld/inquirer/news/local/16414259.htm

Jan 9 - Undersea rover goes where men dare not (Asbury Park Press)
http://www.app.com/apps/pbcs.dll/article?AID=2007701090325

Jan 10 - Rutgers robot is back in business (Philadelphia Inquirer)
http://www.philly.com/mld/inquirer/news/local/16422763.htm

Dec 14 - Flying Underwater at the Bottom of the Planet (ABC News)
http://abcnews.go.com/Technology/GlobalWarming/story?id=2725652&page=1

Some diagrams on how the glider works can be found in the following article
http://marine.rutgers.edu/cool/news/star_ledger_may2006-2.pdf

Palmer Station in Antarctica (check out their web-cam)
http://pal.lternet.edu/

Weather Underground forecast for Palmer Station
http://www.wunderground.com/global/stations/89061.html

More pictures and maps
http://www.usap.gov/videoClipsAndMaps/

Well, there you have it. Cool science, in a cool place from a cool room. If your classes have any questions on this experiment, I'd be happy to try and answer them.

Cheerio,

Sage Lichtenwalner

Institute of Marine and Coastal Sciences
Rutgers, The State University of New Jersey
71 Dudley Road, New Brunswick, NJ 08901
Phone: (732) 932-6555 x533
Email: sage@marine.rutgers.edu

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Mid Atlantic

RTD Activity Idea #4 - 100th Glider Mission

March 18, 2007

With each mission, gliders are proving themselves to be one of the most innovative, adaptable and effective platforms for sampling the ocean.

The Rutgers University Coastal Ocean Observation Lab has been flying gliders for almost 4 years, and has been working with the manufacturer, Webb Research, since 1999 to help them improve the glider's design. On March 13, RU COOL reached a major milestone, and launched the 100th glider mission from the coast of Massachusetts, off the UMass-Dartmouth vessel "Lucky Lady."

But unlike many of our other missions that tend to focus on small areas, this mission will take the glider from the coast of MA, to the continental shelf where it will zig-zag it's way down to NJ, and finally swim into shore. This will be no easy feat, for there are numerous shipping lanes that cross the area, and we have already lost a few gliders to passing ships. But if the mission is successful, the glider will travel a distance of over 500km. Plus, this glider is carrying an onboard bio-optics package, to measure biological activity and sediment in the ocean, which will provide a huge amount of information on how biological productivity in the ocean might affect physical processes over such a large region. Along the way it will even meet up with a research ship, assisting in the study of Atlantic fisheries.

The 100th glider mission continues to break ground, providing scientists a wealth of new data in one of the most interesting areas of the ocean, while demonstrating yet again that robotic gliders are capable of flying long distances in dangerous terrain, with just a little help from their pilots.

A) Real-time Data Project

The 100th Glider Mission is being flown by glider "RU16." Real-time data from the glider can be found on the following page.
http://marine.rutgers.edu/cool/auvs/?page=deployments

You can select different "transects" (broken-up segments of data) using the pull-down bar. Note that the profile plots of data correspond to slices of the ocean underneath the line shown on the transect map starting from the green (start) circle and heading towards the red (stop) circle.

RU16 has a traditional CTD package which measures conductivity (from which salinity is calculated), temperature and depth (calculated from the water pressure around the glider).

It also has a bio-optics package, which uses LED lights and optical sensors to measure the "color" of the ocean. In particular, it can measure Chlorophyll-a, which is a pigment used in most plant life and thus is a good indicator of the concentration of phytoplankton. And it can also measure "Optical Backscatter," which in effect tells us how much "stuff" is in the water, especially sediment, plankton and detritus. (Several graphs showing optical backscatter at different "wavelengths" are included, but for the most part they show the similar results. For simplicity, any one could be chosen to compare with the other graphs.)

Because of the importance of this mission, RU COOL scientists decided to start a blog, which details the technical challenges of the mission, along with scientific explanations of the cool results they are observing.
http://gliderflight100.blogspot.com/

We encourage you and your students to read along, and if you have questions about the data, scientific results, how the glider works or why the scientists are studying this area, please feel free to ask them by commenting on the blog.

B) Engaging Questions

Here are a few questions students can think about before they start their research.

- What advantages are there for scientists to use robotic gliders to study the ocean? (i.e. cost, range, automated sampling, doesn't get seasick.)
- What challenges might a robot face in completing it's mission? (i.e. battery power, being hit and damaged by ships, leaking, staying on course underwater without GPS, being pushed around by strong currents, maintaining satellite communication.)
- Why do scientists study the ocean off the Mid-Atlantic states? (i.e. Lots of people in the area, lots of shipping, one of the most dynamic areas of the ocean in the world, and one of the largest annual temperature ranges.)
- Why do scientists care about the temperature, currents or biological productivity of the ocean?

C) Suggested Research Questions

Here are several questions students can try to answer by looking at the data.

- Analyze the temperature plots, and convert the temperature scale to Fahrenheit if necessary. What is the difference in temperature and salinity from the water's surface, to the bottom of the measured profile? Is this a large difference?
- Does this difference change at all in the horizontal direction?
- Might this difference be different during other times of the year? (i.e. summertime heating of the surface layer or rainfall in the spring/fall freshening the surface layer.)
- Compare the plots of temperature, salinity & density. Do you see any relationships between them?
- Is there any relationship between these factors and chlorophyll or optical backscatter? What might explain this?
- Look at several transects and observe where maximum chlorophyll values are? Close to shore or offshore? In a layer near the surface, middle or bottom of the water column? What factors might explain where this occurs?
- On the transect maps several blue and red lines are plotted. Identify what these lines are and determine why scientists have included them on their charts for this mission.

- In the first transect (3/17-3/18) there is a large gap of no data near the surface. Look at the transect map and determine why there is no data here. You can check your answer by reading the early entries on the blog.
- Take a look at the current Codar Surface Currents and locate the glider's current position. http://marine.rutgers.edu/cool/codar/real-time/archiveviewer_mab1day.php) The glider can travel ~50cm/s on it's own. Are there any areas on the map in which the glider would would have trouble staying on course? If you go back in time, were there any times when at the glider's current location it would have had trouble?

By following along on the Mission Blog, you can find the answers to these questions and can learn about other interesting observations the glider is making. You and your students can also ask questions about features you see in the glider data, how scientists are controlling the glider, and why the information being collected by the glider is important to study.

D) Relevant References

Here is a recent news article on the 100th Glider mission's launch.
http://www.app.com/apps/pbcs.dll/article?AID=/20070314/NEWS03/703140319/1007/BUSINESS

For further background information and some cool diagrams on how the glider works, check out the following Star Ledger articles.
http://marine.rutgers.edu/cool/news/star_ledger_may2006.pdf
http://marine.rutgers.edu/cool/news/star_ledger_may2006-2.pdf

Don't forget the Mission Blog!
http://gliderflight100.blogspot.com/

I hope you enjoy interacting with the data and following along with the scientists as we continue this milestone journey.

I would love to hear any feedback you have about the data, my activity ideas and what you and your students are interested in. And as always, if you have any questions please feel free to call or email me.

Cheers,

Sage Lichtenwalner

Institute of Marine and Coastal Sciences
Rutgers, The State University of New Jersey
71 Dudley Road, New Brunswick, NJ 08901
Phone: (732) 932-6555 x533
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Comparing Climates in the United States

Ideas for a Secondary Research Project

When meteorologists talk about the "weather," they describe the current conditions in the atmosphere, like the temperature, humidity, how windy it will be or whether it will rain. Knowing the weather tells us what is happening right now. But in order to predict the weather, meteorologists first need to know what conditions they might normally expect on any given day for a specific location. To do so, they can access data about their city's climate.

"Climate" describes an average of weather conditions over a long time (such as 30 year period). It is useful for putting the weather on any given day in perspective. Today might be a very cold day, but is it any colder than previous years? Climate is also useful for comparing the typical weather conditions of two cities. If we just look at one day's weather we might get the wrong idea. For example, say we would like to move to somewhere where it doesn't rain much. If we looked at today's weather and saw it was sunny Seattle while it was raining in New York, we might decide to move to Seattle, only to be disappointed by how often it actually rains there. We would have gotten a more accurate picture by researching its climate.

Many things affect the climate of a city. How far North of the equator is it? Is it near an ocean? Is it next to a lake? How high above the sea is it (elevation)? Is it next to a mountain? Some of these factors affect temperature, some affect rain or snowfall, and some affect both. You can easily analyze these effects by comparing the climates of two or more cities together.

Things to Think About Before You Start Your Research

- What is climate?
- What is the difference between climate and weather?
- What factors can influence climate variability?
- What processes can cause climate to change over time?

Research Questions

- Do cities at the same latitude (their north/south position) have the same climate?
- What differences in climate are there between northern and southern cities?
- Do mountains or the Great Lakes affect the rain or snowfall amounts of cities nearby?
- How does the weather in the Great Plains compare with that along the coasts?

Cool Datasets

The City-Data site includes ready-made climate graphs for hundreds of cities across the US.
http://city-data.com/

If you would like to make your own graphs using Microsoft Excel or another program, you can obtain monthly climate data easily for many cities from the following NOAA site.
http://ols.nndc.noaa.gov/plolstore/plsql/olstore.prodspecific?prodnum=C00095-PUB-A0001#TABLES

Example References

- NOAA Climate Information – http://www.noaa.gov/climate.html
- State Climate Descriptions – http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl?directive=prod_select2&prodtype=CLIM60
- National Color Climate Atlas Maps – http://gis.ncdc.noaa.gov/website/ims-climatls/

The Ocean & Atmosphere

Ideas for a Secondary Research Project

It is no secret that conditions in the ocean are influenced by conditions in the atmosphere (the air) above the ocean. The wind is a major force that drives the ocean's currents, and it is also responsible for building up waves on the surface of the ocean. Strong winds and high waves can cause dangerous conditions for boats on the water, or interfere with shipping. They can also cause beaches to *erode* away. But high waves can be good too, especially if you're a surfer.

While the atmosphere affects the ocean, it is also true that the ocean affects conditions in the atmosphere. Cities near the ocean tend to have much more moderate climates than those cities further inland. This is because the ocean has a much greater *heat capacity* than the land, which keeps the temperature of the air from changing too quickly. *Sea breezes*, or strong localized winds that form along the coast during the day, also arise from the different temperatures of the ocean, atmosphere and land. But perhaps the most significant example of the ocean's influence on the atmosphere is in the creation of *hurricanes*. Warm tropical waters provide developing hurricanes with the energy they need to strengthen and grow. The ocean and atmosphere are closely linked and directly affect life on Earth.

You can easily study many of these interactions between the ocean and the atmosphere by analyzing data from weather instruments mounted on buoys in the ocean.

Things to Think About Before You Start Your Research:

- What is the difference in heat capacities between the ocean, land and the atmosphere?
- How do winds affect the ocean?
- In what ways do the ocean and atmosphere interact?
- How can the ocean affect the weather?

Research Questions

- Do ocean temperatures change much more gradually than air temperatures? (Compare the temperature of the sea and air from one buoy over the course of a month or a year. Concept: heat capacity.)

- Are waves affected by winds? (Compare "wind speeds" and "wave heights." Concept: energy transfer.)
- Are wave heights greater in the winter when more storms occur in the Northeast? (Analyze plots of wave height and compare with temperature to verify the season. Concept: seasons.)
- Does the depth of the ocean affect wave heights? (Compare climatic plots of near-shore and offshore buoys, like #44025 and #44004. Concept: bottom friction.)
- Do storms affect sea temperatures and waves? (Over a month, keep a journal of the real-time conditions at a selected buoy. Be sure to record temperature, wind speed, wave height and the current weather at your location, like is it sunny, raining or windy.)

Cool Datasets

The National Data Buoy Center (NDBC) web site features real-time and historical weather and water data from hundreds of buoys across the world. We recommend choosing sites marked as blue squares ("NDBC Moored Buoys"). Once you have selected a buoy, you can download "standard meteorological data" files and import them into a graphing program like Microsoft Excel. If you do not want to plot your own data, many stations also include "climactic summary plots" which can be easier to use.
http://ndbc.noaa.gov/hmd.shtml

To access real-time buoy data you can go to the following site:
http://ndbc.noaa.gov/rmd.shtml

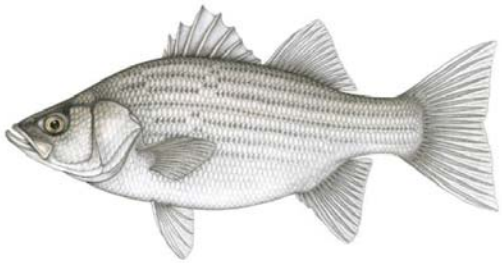
Example References

- JetStream Ocean – http://www.srh.noaa.gov/jetstream/ocean/oceans_intro.htm

Animal Migrations and Ocean Temperature

Ideas for a Secondary Research Project

If you have spent any time in, on, or near the ocean you know that the temperature of the water in many areas can change from season-to-season, day-to-day, and even hour-to-hour. As humans, we tend to only want to swim in the ocean if it is very warm (unless we have a wetsuit on). Since waters around Florida are typically warm, we can swim there year-round. In New York, the water is warm between July and September. But in Massachusetts, it might only be warm enough to swim in August.



Just like us, fish and other animals that live in the ocean have their own preferences. Some prefer warm waters, some like it cold, and others don't mind at all. Since the temperature of the ocean changes daily, and throughout the year, animals that prefer a constant temperature must move, or *migrate*, to waters they can live in. It is important for us to understand the kinds of *habitats* animals and plants like to live so we can manage fish stocks well to prevent *over-fishing*.

Once we know the temperature range a particular species prefers to live in, we can map where they might live throughout the year if we have a map of the ocean's temperature. We can also use this information to determine their migration pattern. For example, adult *Striped Bass* prefer water temperatures between 20-23°C. Sensors on satellites hundreds of miles above the Earth provide the ideal place to map ocean temperatures over a large area. The satellites send the information back to Earth where colored *Sea Surface Temperature* (SST) images, or maps, are created to show the temperatures of water in different areas. Red typically indicates the warmest temperatures, and blue and purple areas are the coldest.

You can use the same SST maps scientists use to determine where fish like Striped Bass prefer to live throughout the course of a year. By measuring the temperature of several locations along the Mid-Atlantic coast, you can determine when they might be found at each point.

Things to Think About Before You Start Your Research

- What is a habitat?
- What is the preferred habitat of Striped Bass (or another species like dolphins or tuna)?
- How do Striped Bass (or another species) migrate?
- Why are phytoplankton important in the ocean?

Research Questions

- Are ocean temperatures related to seasons?
- Is the migration of Striped Bass related to temperature? Over the course of a year, during which months are you likely to find Striped Bass off North Carolina (76W/35N), New Jersey (74W/40N), and Massachusetts (70W/42N)?
- Does the Gulf Stream flow along Long Island? (Compare 74W/35N and 72W/40N)
- Does the shallow continental shelf around New York influence ocean temperatures? (Compare 72W/40N vs. 64W/36N. Concept: heat capacity.)

Cool Datasets

Daily images of Sea Surface Temperature for the Mid-Atlantic are available from RU COOL (that's at Rutgers University). This site provides easy access to data going back many years. Additional maps from Florida to Maine are also available. We recommend choosing one good colorful image per month, as close to the same day as possible, for your analysis.
http://marine.rutgers.edu/cool/sat_data/?product=sst_comp&region=bigbight

Just like many animals on land eat grass, animals in the sea eat *phytoplankton*. Ocean Chlorophyll maps show where this ocean "grass" is growing, and where many other animals can be found.
http://marine.rutgers.edu/cool/sat_data/?product=chlor&region=bigbight

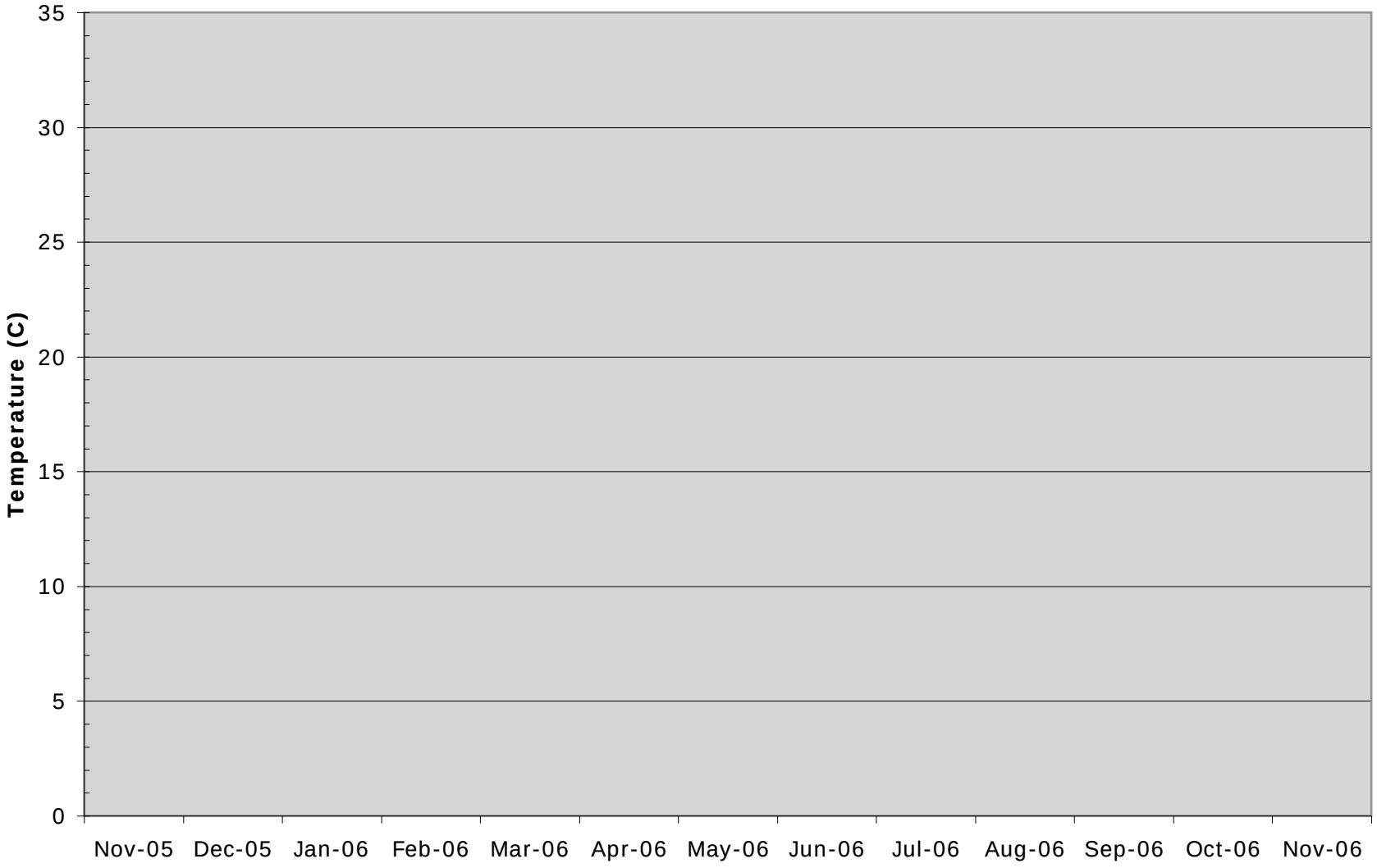
Example References

- StriperTracker – http://stripertracker.org/
- COOL Classroom Satellites – http://coolclassroom.org/whats_cool/remotesensingsat.html
- The COOLroom – http://www.thecoolroom.org/fishermen/fish_help_sst.htm

Ocean Temperature & Migration Worksheet

Point Name:			
Location:	Lat: _____ Lon: _____	Lat: _____ Lon: _____	Lat: _____ Lon: _____
Nov-05			
Dec-05			
Jan-06			
Feb-06			
Mar-06			
Apr-06			
May-06			
Jun-06			
Jul-06			
Aug-06			
Sep-06			
Oct-06			
Nov-06			

Ocean Temperatures

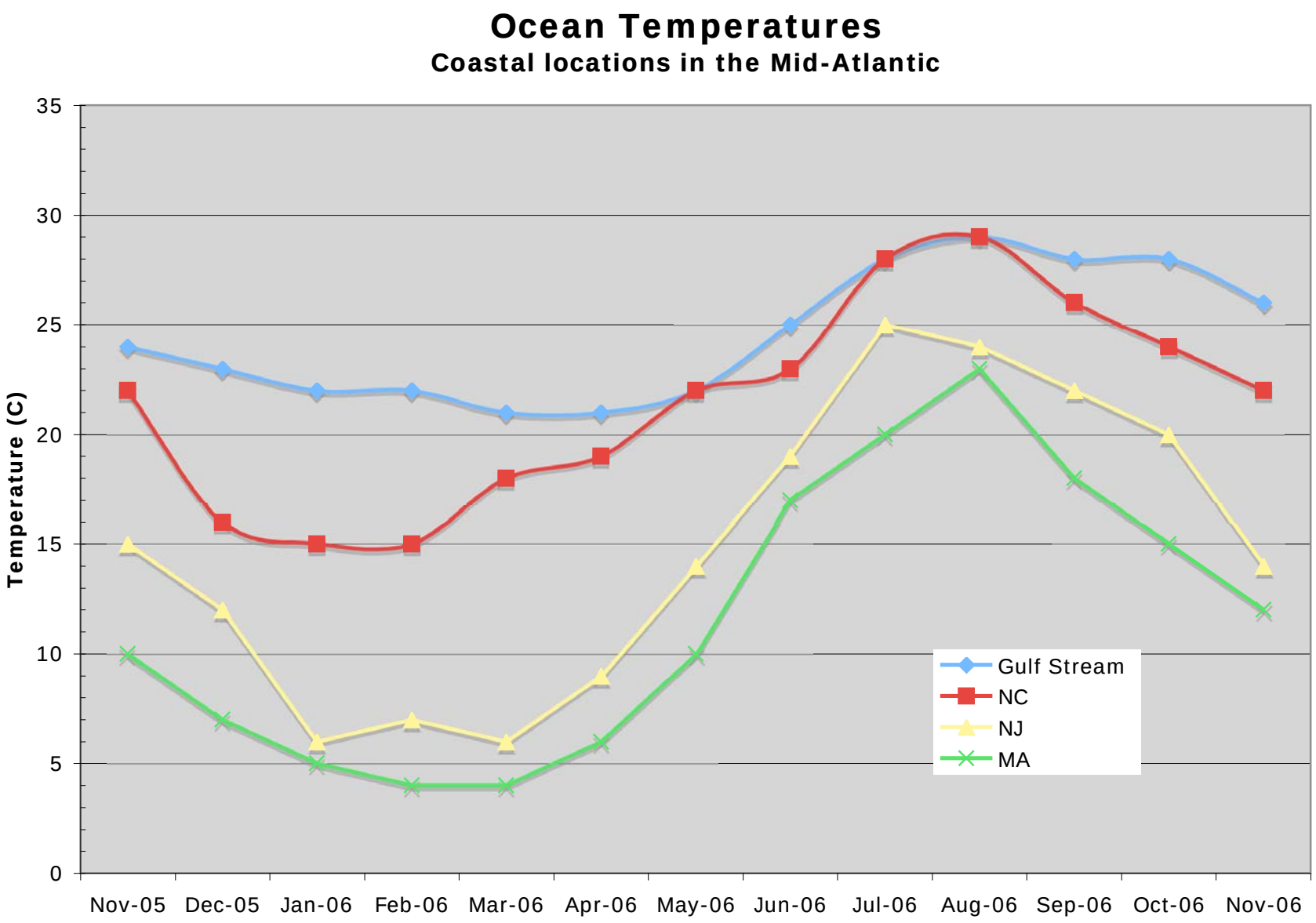


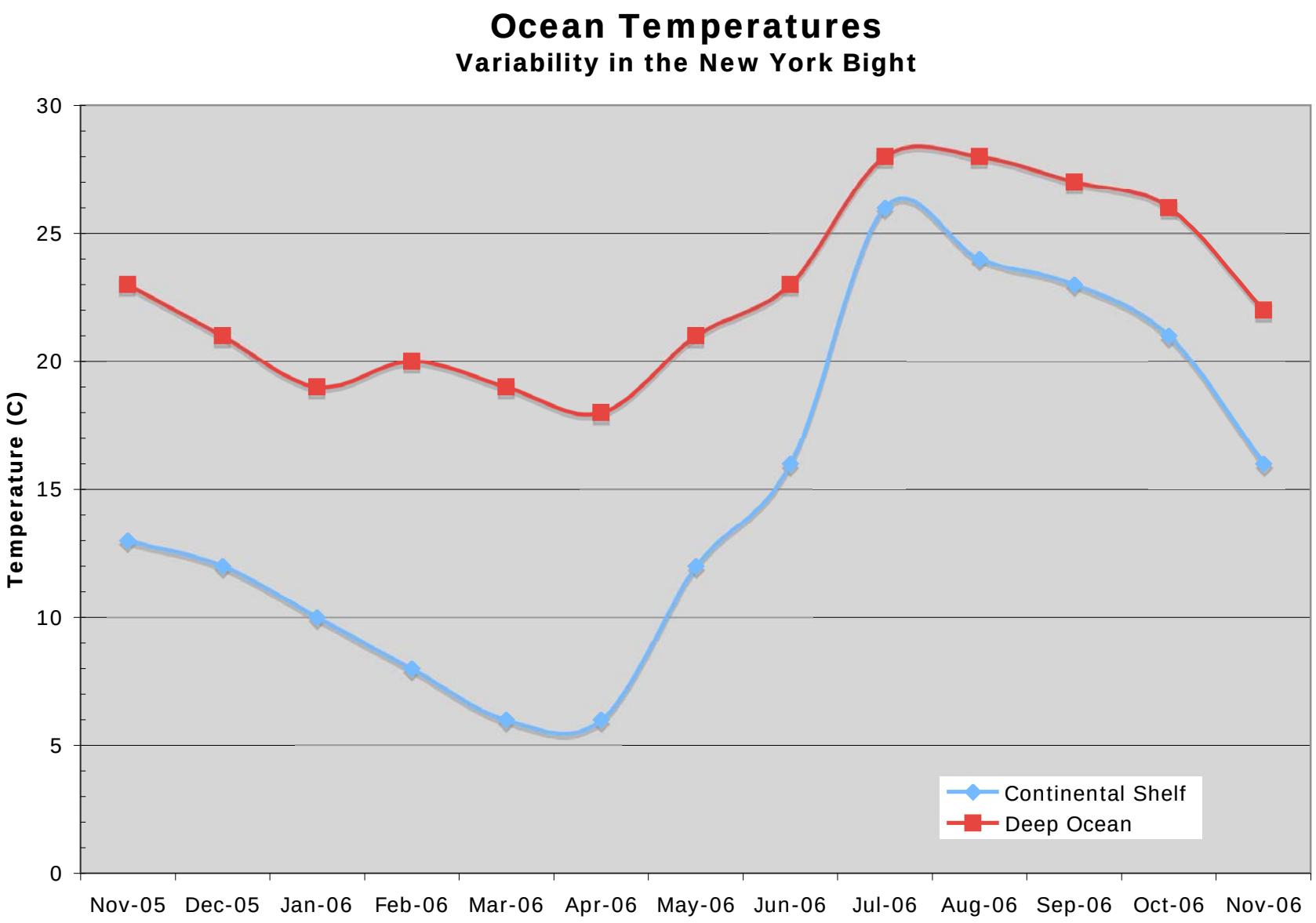
Temperature in Celsius for an offshore (deep) and nearshore (shallow) location

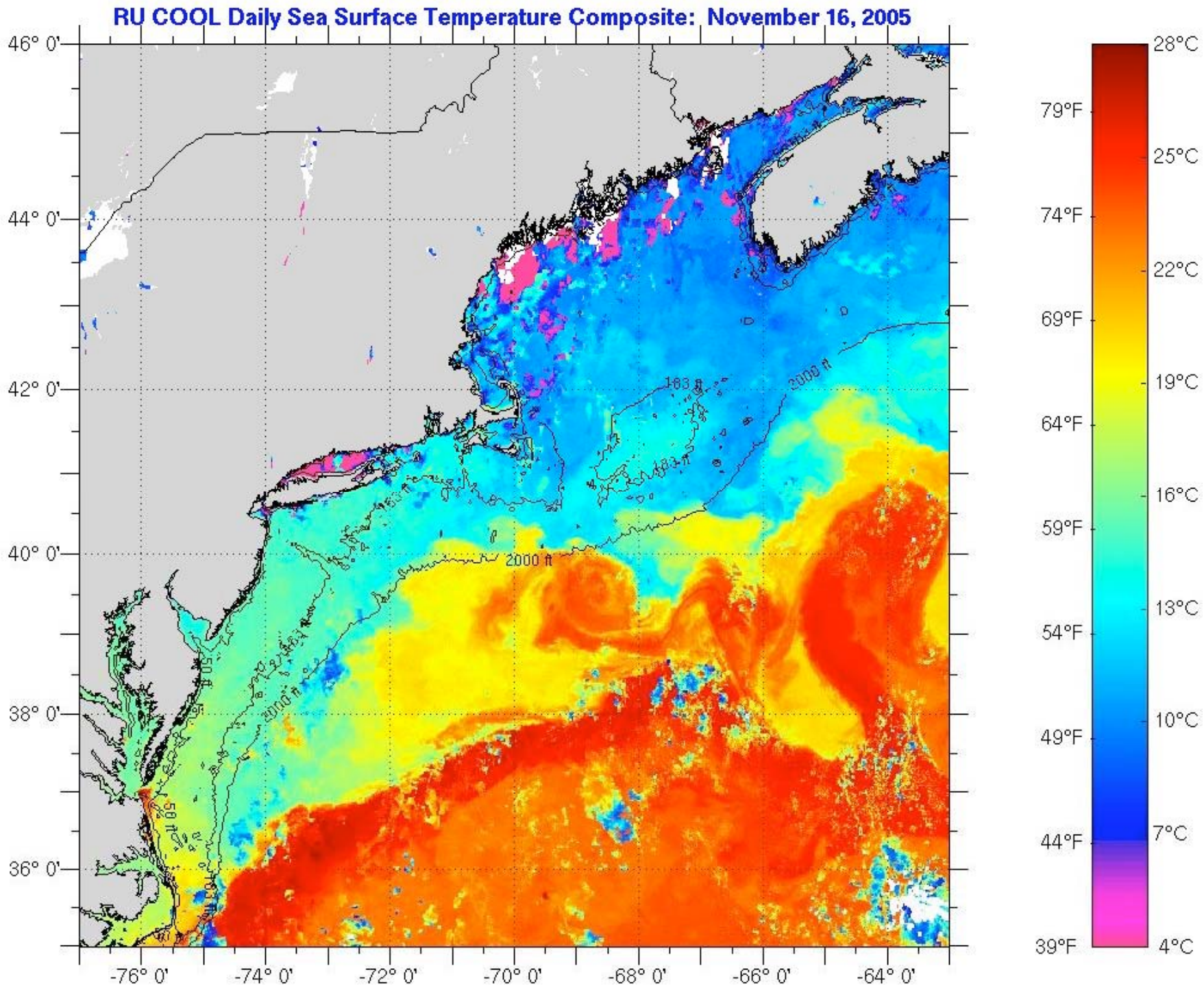
	Continental Shelf (72W 40N)	Deep Ocean (64W 36N)
Nov-05	13	23
Dec-05	12	21
Jan-06	10	19
Feb-06	8	20
Mar-06	6	19
Apr-06	6	18
May-06	12	21
Jun-06	16	23
Jul-06	26	28
Aug-06	24	28
Sep-06	23	27
Oct-06	21	26
Nov-06	16	22

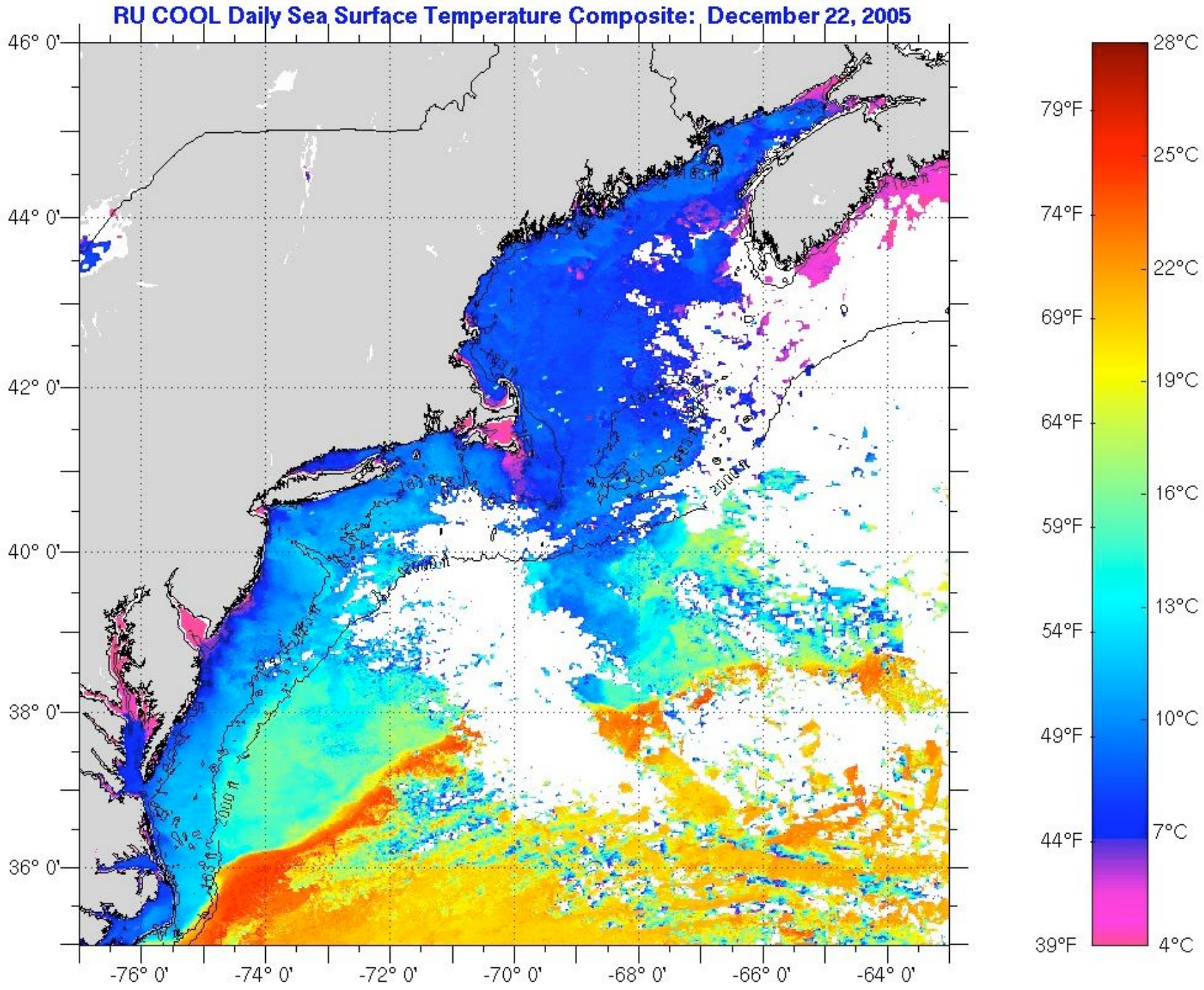
Temperature in Celsius of locations along the Mid-Atlantic

	Gulf Stream (74W 35N)	NC (76W 35N)	NJ (74W 40N)	MA (70W 42N)
Nov-05	24	22	15	10
Dec-05	23	16	12	7
Jan-06	22	15	6	5
Feb-06	22	15	7	4
Mar-06	21	18	6	4
Apr-06	21	19	9	6
May-06	22	22	14	10
Jun-06	25	23	19	17
Jul-06	28	28	25	20
Aug-06	29	29	24	23
Sep-06	28	26	22	18
Oct-06	28	24	20	15
Nov-06	26	22	14	12


Ocean Temperatures
Coastal locations in the Mid-Atlantic
Temperature (C)
35
30
25
20
15
10
5
0
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Oct-06
Nov-06
Gulf Stream
NC
NJ
MA


Ocean Temperatures
Variability in the New York Bight
Temperature (C)
30
25
20
15
10
5
0
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Oct-06
Nov-06
Continental Shelf
Deep Ocean


RU COOL Daily Sea Surface Temperature Composite: November 16, 2005
46° 0'
44° 0'
42° 0'
40° 0'
38° 0'
36° 0'
-76° 0'
-74° 0'
-72° 0'
-70° 0'
-68° 0'
-66° 0'
-64° 0'
2000 ft
163 ft
50 ft
28°C
25°C
22°C
19°C
16°C
13°C
10°C
7°C
4°C
79°F
74°F
69°F
64°F
59°F
54°F
49°F
44°F
39°F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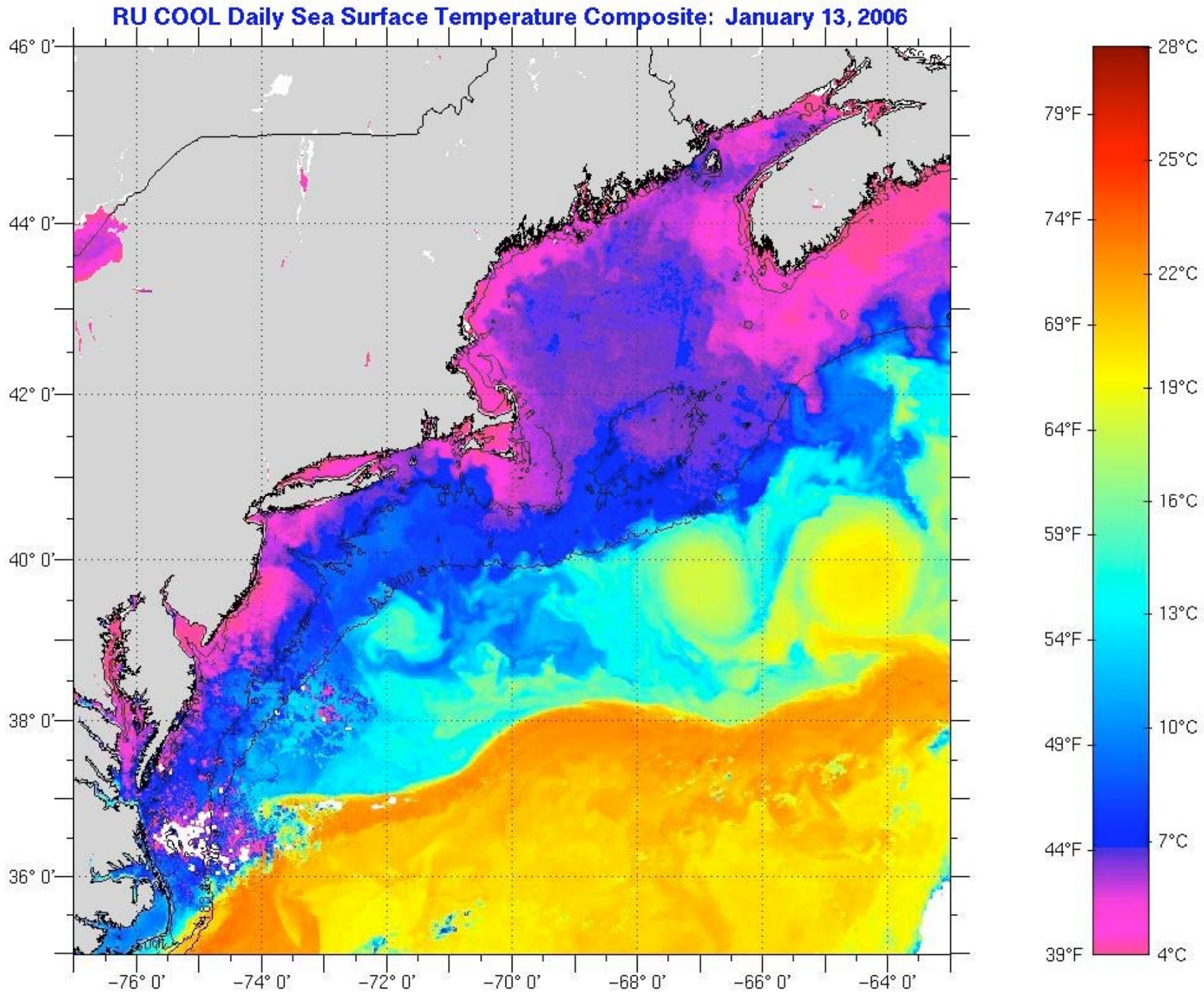
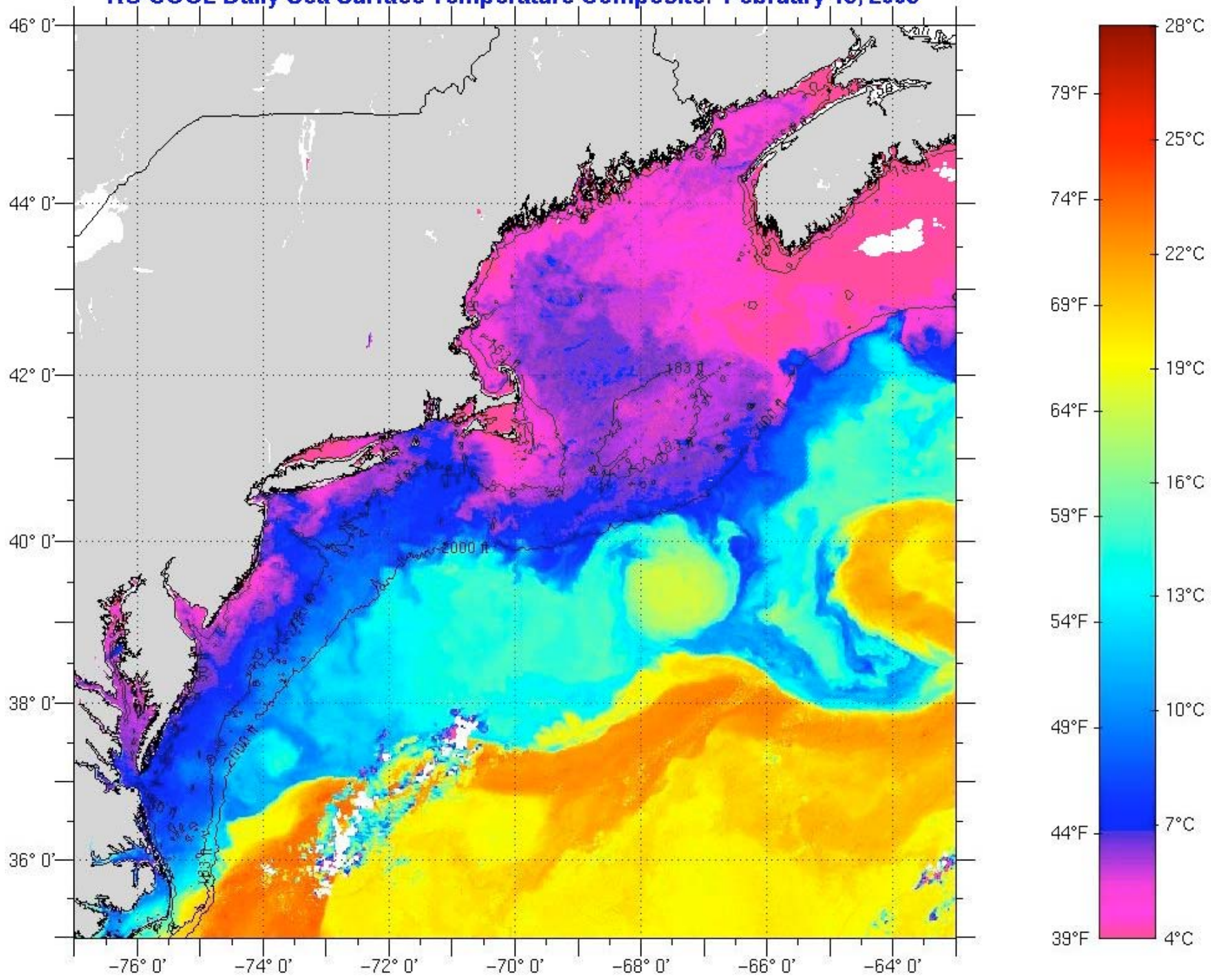
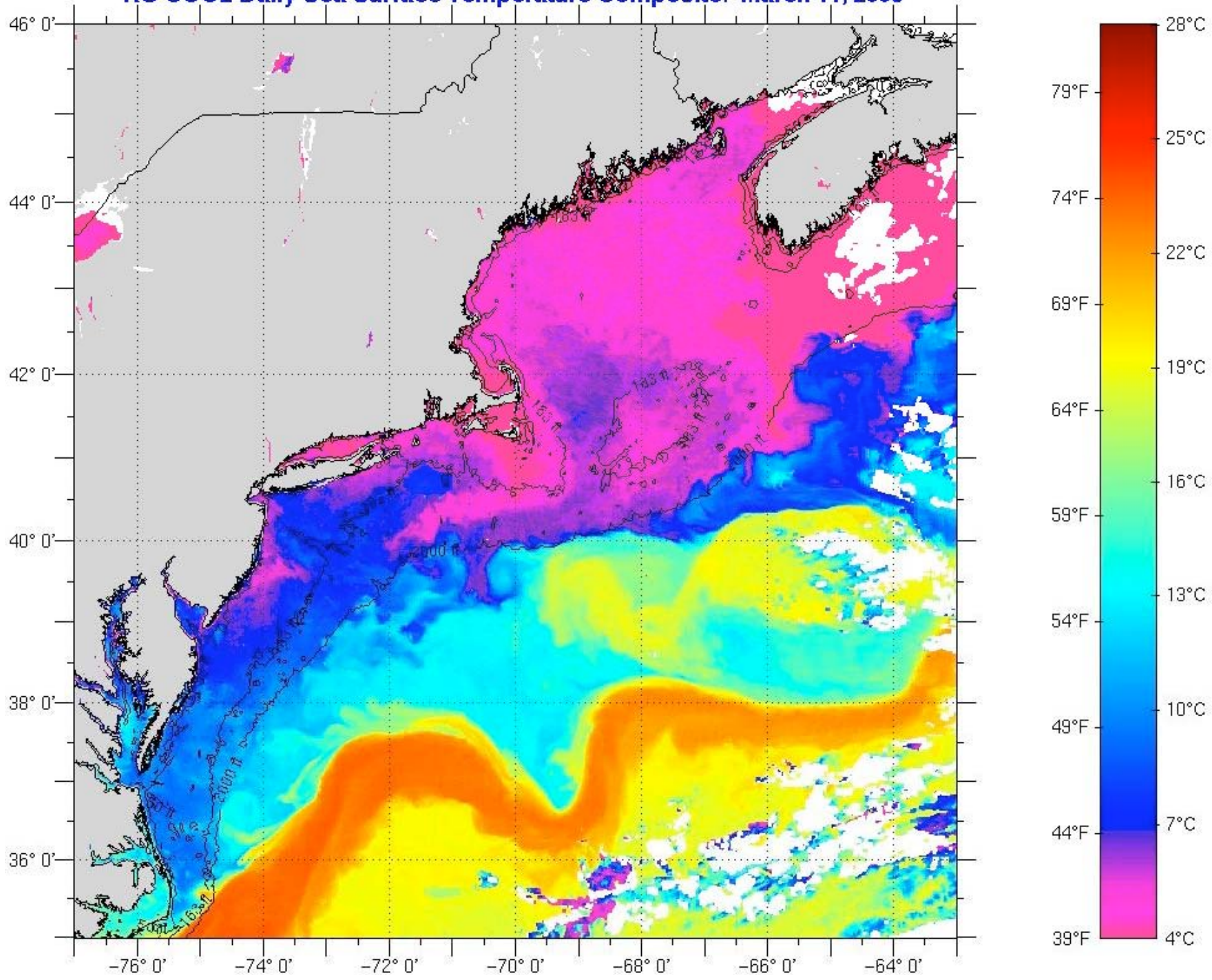
40° 0'
38° 0'
36° 0'
-76° 0'
-74° 0'
-72° 0'
-70° 0'
-68° 0'
-66° 0'
-64° 0'
28°C
25°C
22°C
19°C
16°C
13°C
10°C
7°C
4°C
79°F
74°F
69°F
64°F
59°F
54°F
49°F
44°F
39°F


RU COOL Daily Sea Surface Temperature Composite: January 13, 2006
46° 0'
44° 0'
42° 0'
40° 0'
38° 0'
36° 0'
-76° 0'
-74° 0'
-72° 0'
-70° 0'
-68° 0'
-66° 0'
-64° 0'
28°C
79°F
25°C
74°F
22°C
69°F
19°C
64°F
16°C
59°F
13°C
54°F
10°C
49°F
7°C
44°F
39°F
4°C

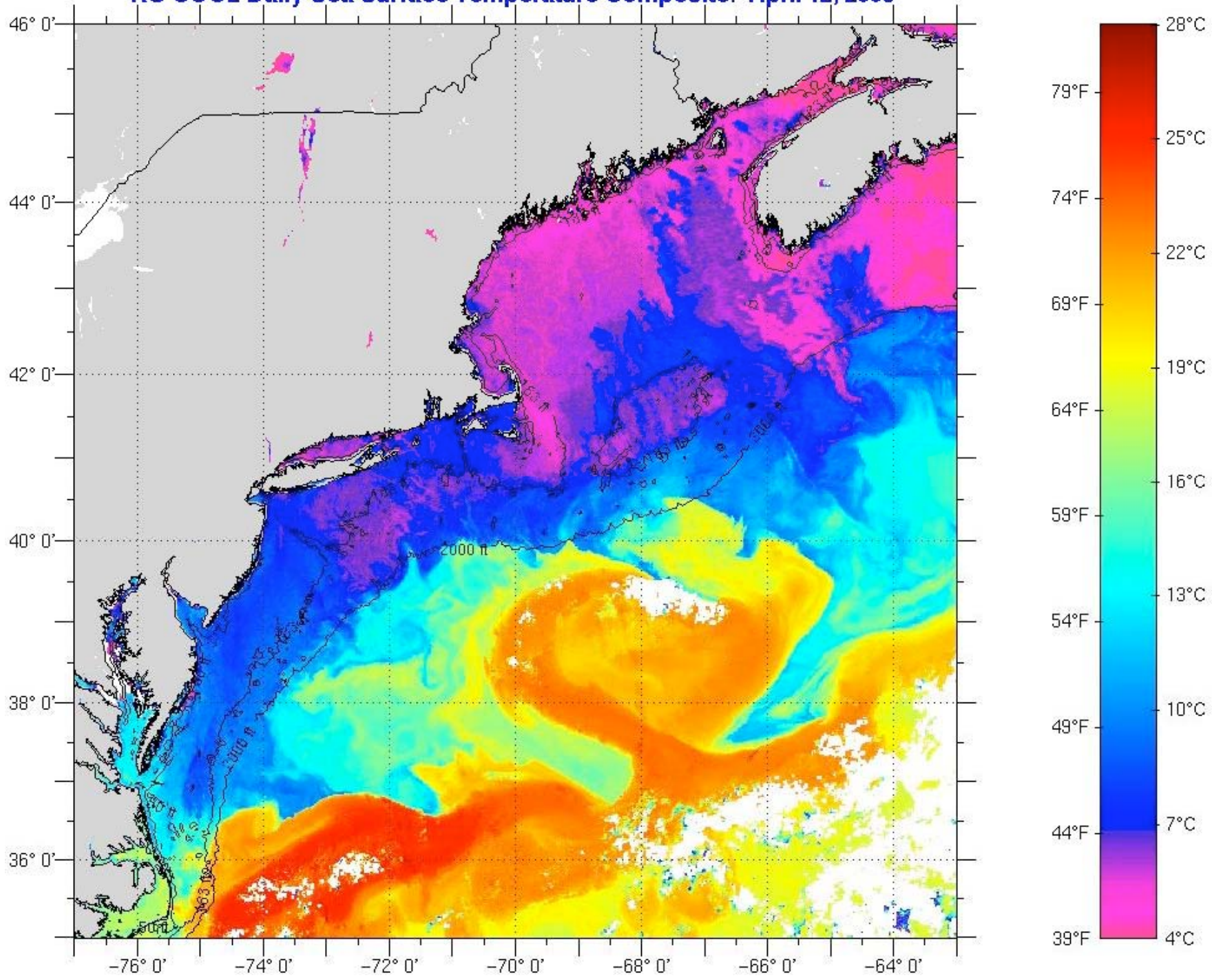
RU COOL Daily Sea Surface Temperature Composite: February 16, 2006



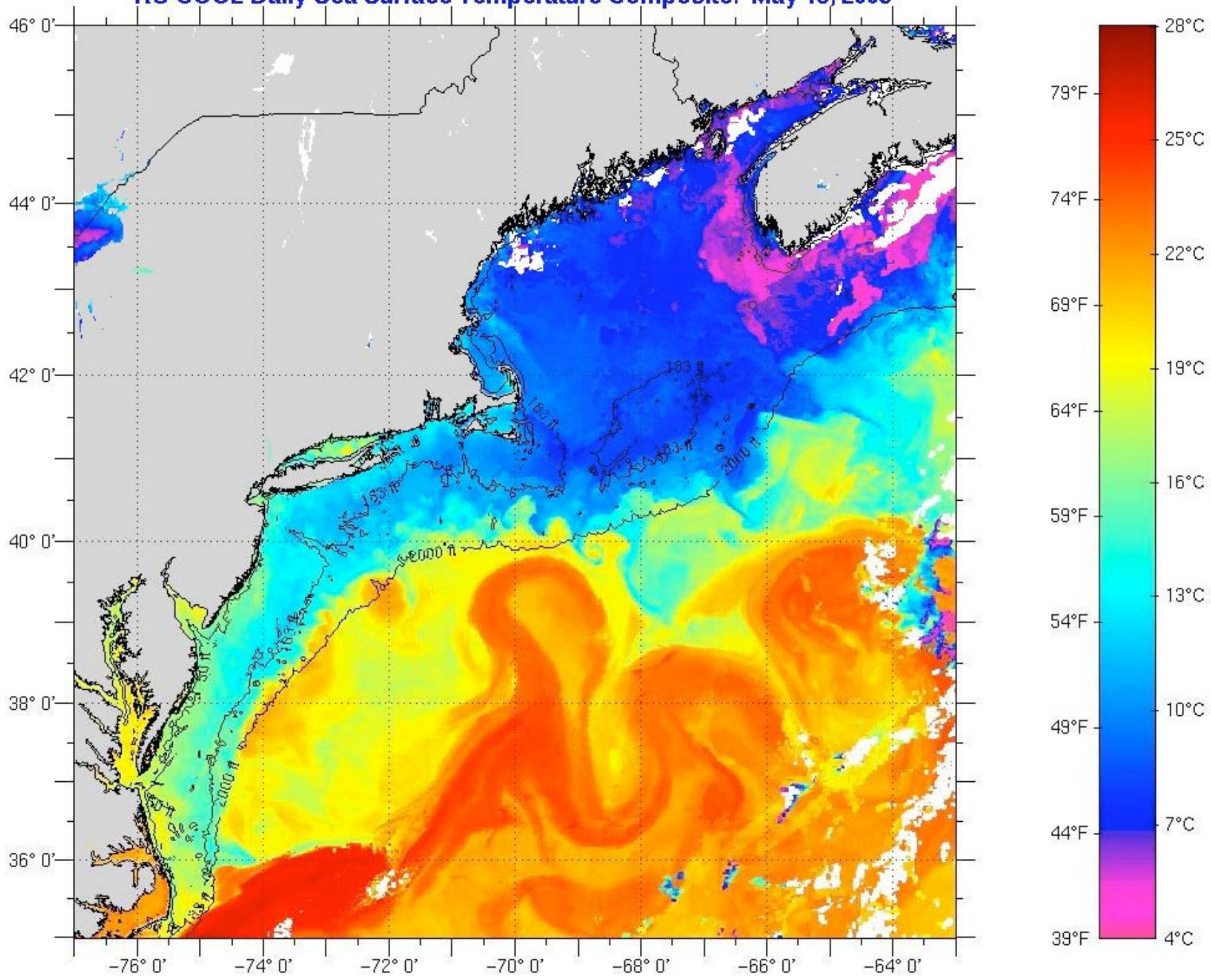
RU COOL Daily Sea Surface Temperature Composite: March 11, 2006

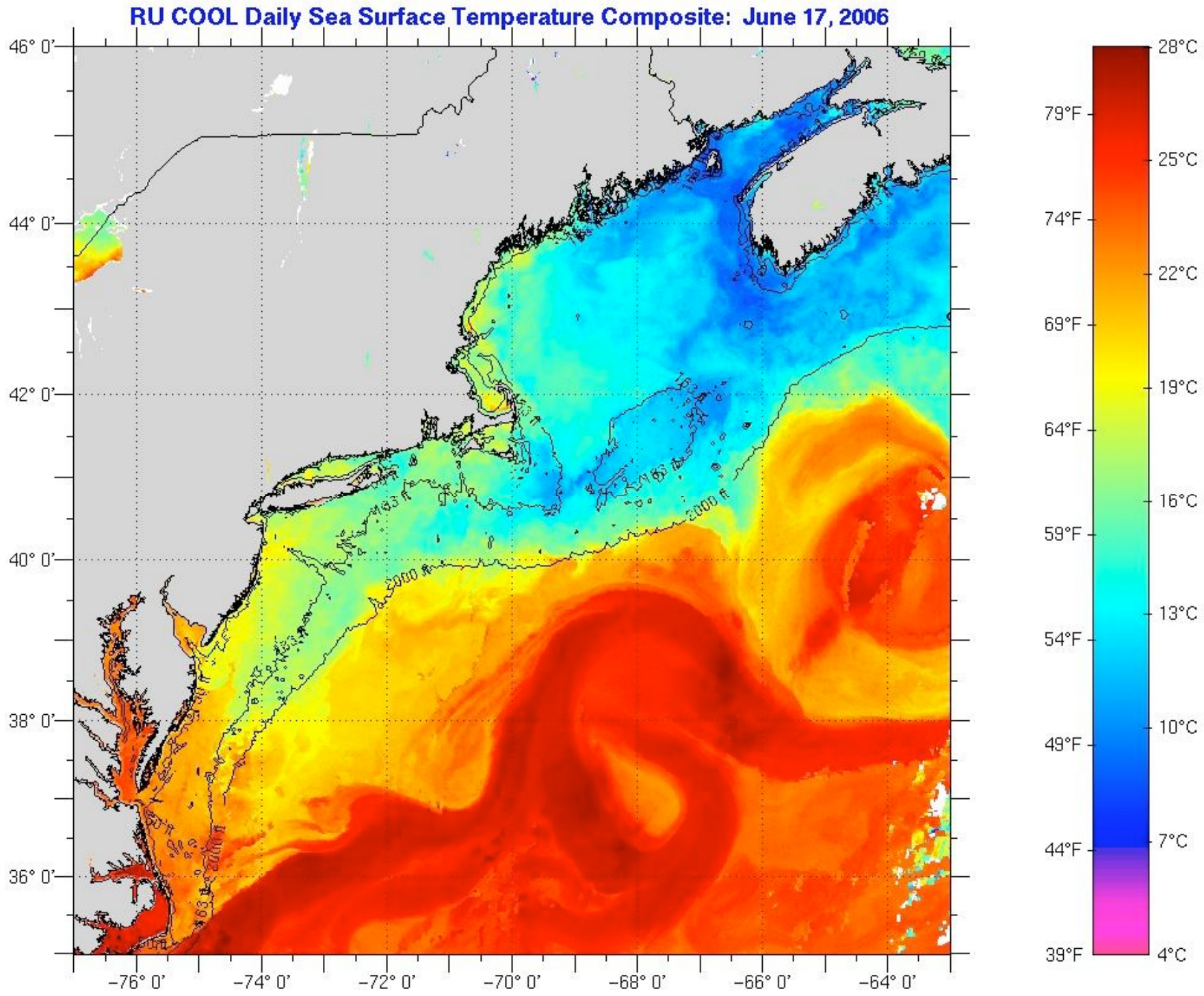


RU COOL Daily Sea Surface Temperature Composite: April 12, 2006



RU COOL Daily Sea Surface Temperature Composite: May 18, 2006




RU COOL Daily Sea Surface Temperature Composite: June 17, 2006
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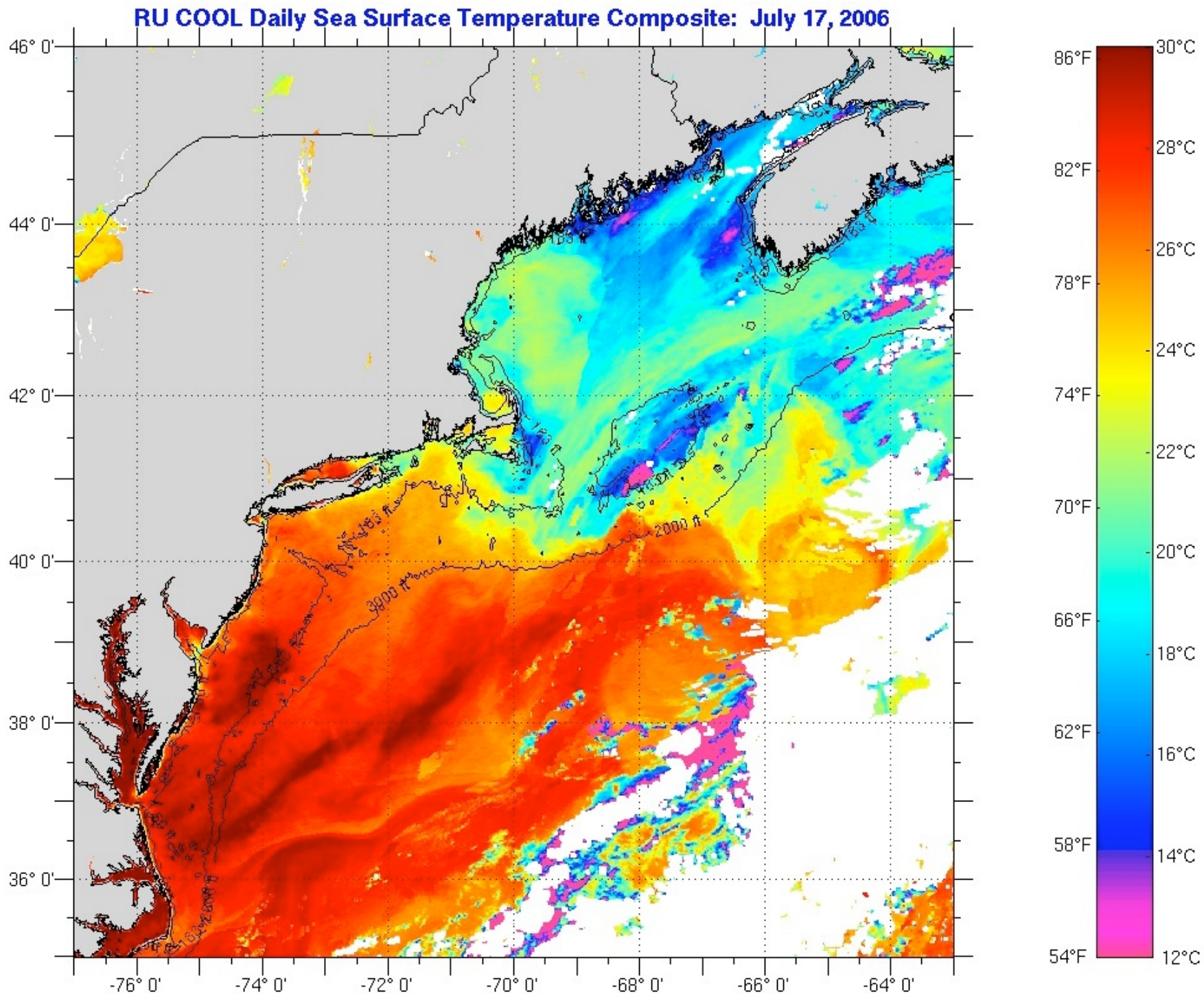
44° 0'
42° 0'
40° 0'
38° 0'
36° 0'
-76° 0'
-74° 0'
-72° 0'
-70° 0'
-68° 0'
-66° 0'
-64° 0'
28°C
25°C
22°C
19°C
16°C
13°C
10°C
7°C
4°C
79°F
74°F
69°F
64°F
59°F
54°F
49°F
44°F
39°F


RU COOL Daily Sea Surface Temperature Composite: July 17, 2006
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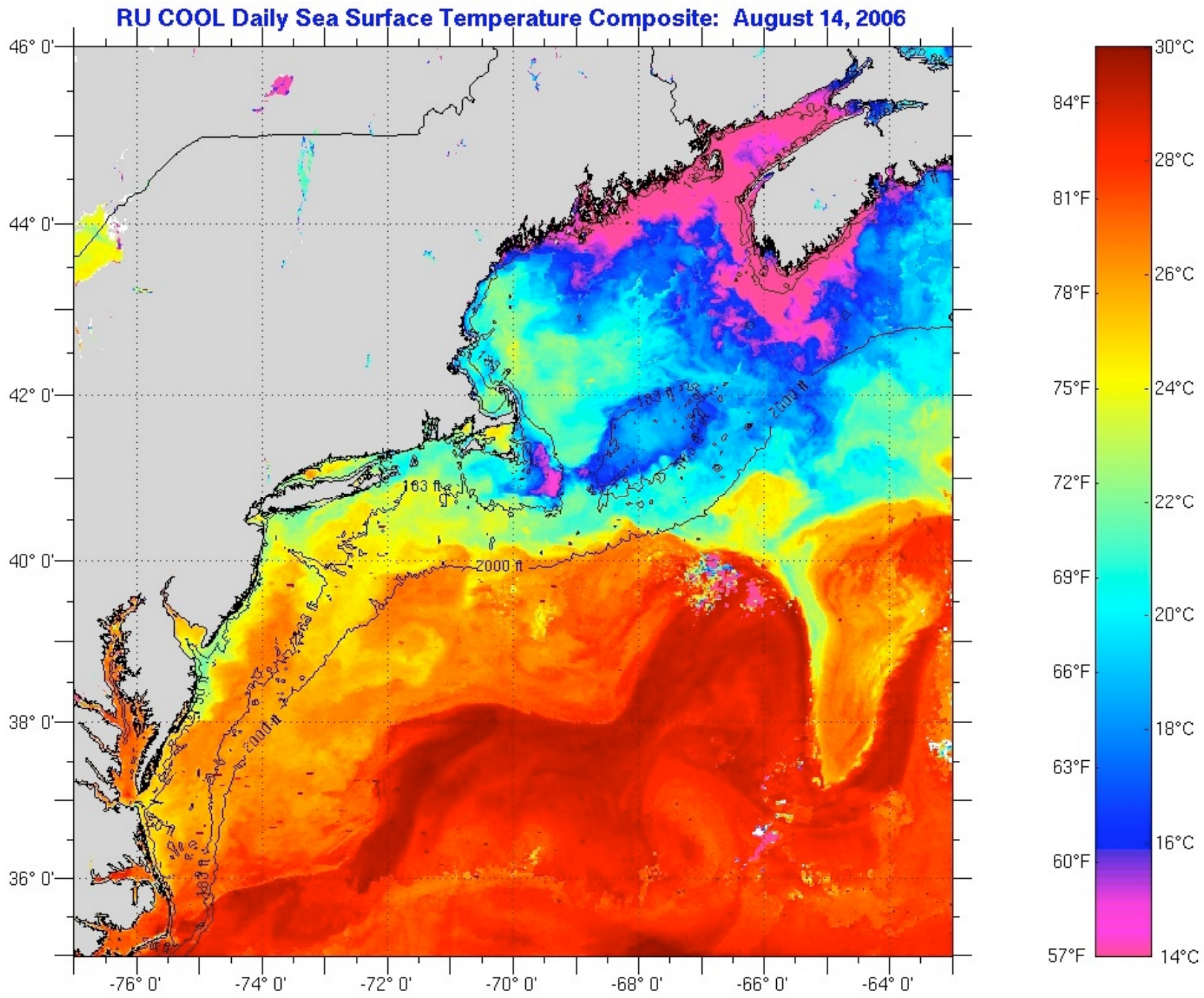
42° 0'
40° 0'
38° 0'
36° 0'
-76° 0'
-74° 0'
-72° 0'
-70° 0'
-68° 0'
-66° 0'
-64° 0'
2000 ft
3000 ft
86°F
82°F
78°F
74°F
70°F
66°F
62°F
58°F
54°F
30°C
28°C
26°C
24°C
22°C
20°C
18°C
16°C
14°C
12°C


RU COOL Daily Sea Surface Temperature Composite: August 14, 2006
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40° 0'
38° 0'
36° 0'
-76° 0'
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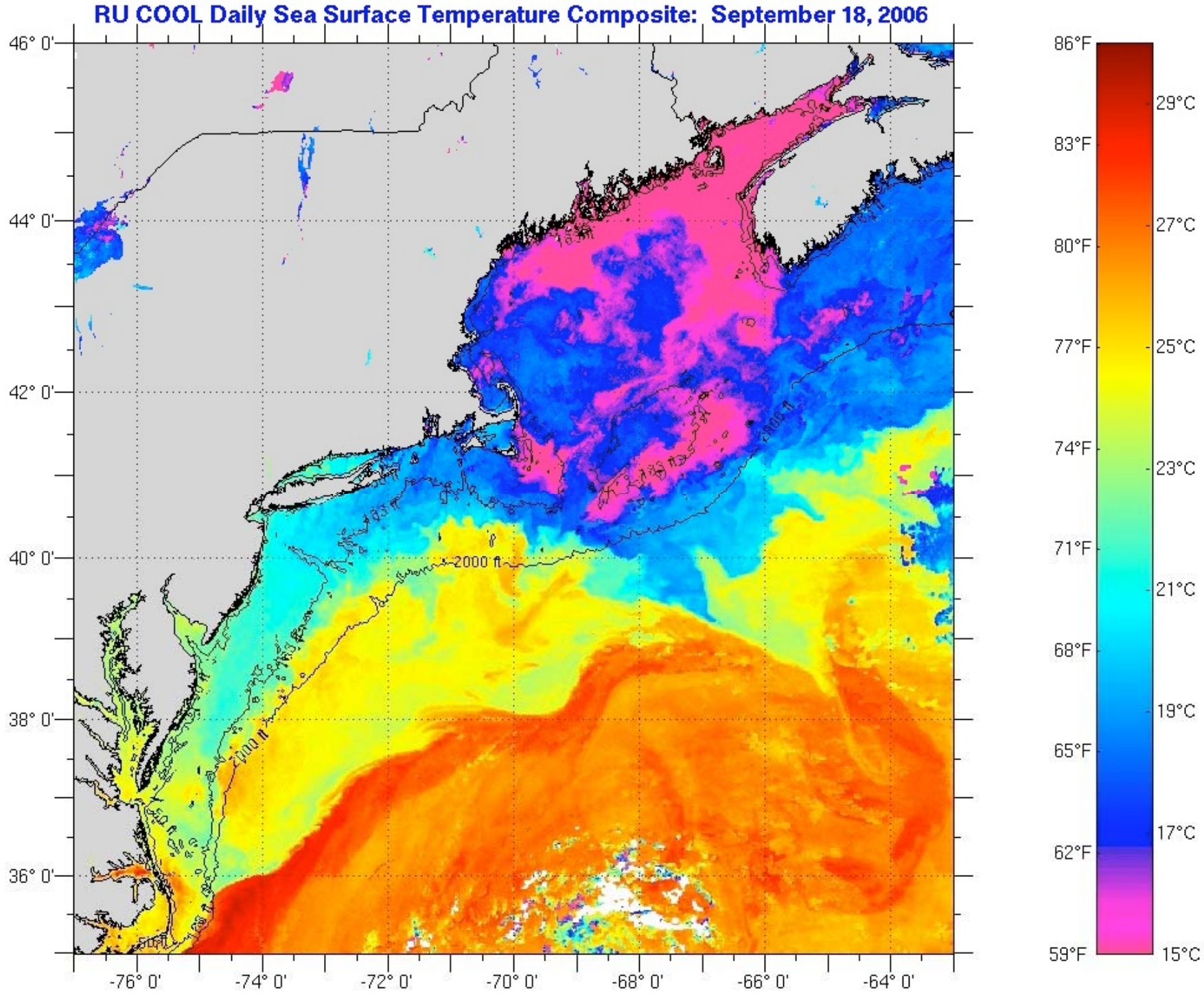
-70° 0'
-68° 0'
-66° 0'
-64° 0'
163 ft
2000 ft
30°C
28°C
26°C
24°C
22°C
20°C
18°C
16°C
14°C
84°F
81°F
78°F
75°F
72°F
69°F
66°F
63°F
60°F
57°F


RU COOL Daily Sea Surface Temperature Composite: September 18, 2006
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40° 0'
38° 0'
36° 0'
-76° 0'
-74° 0'
-72° 0'
-70° 0'
-68° 0'
-66° 0'
-64° 0'
2000 ft
86°F
83°F
80°F
77°F
74°F
71°F
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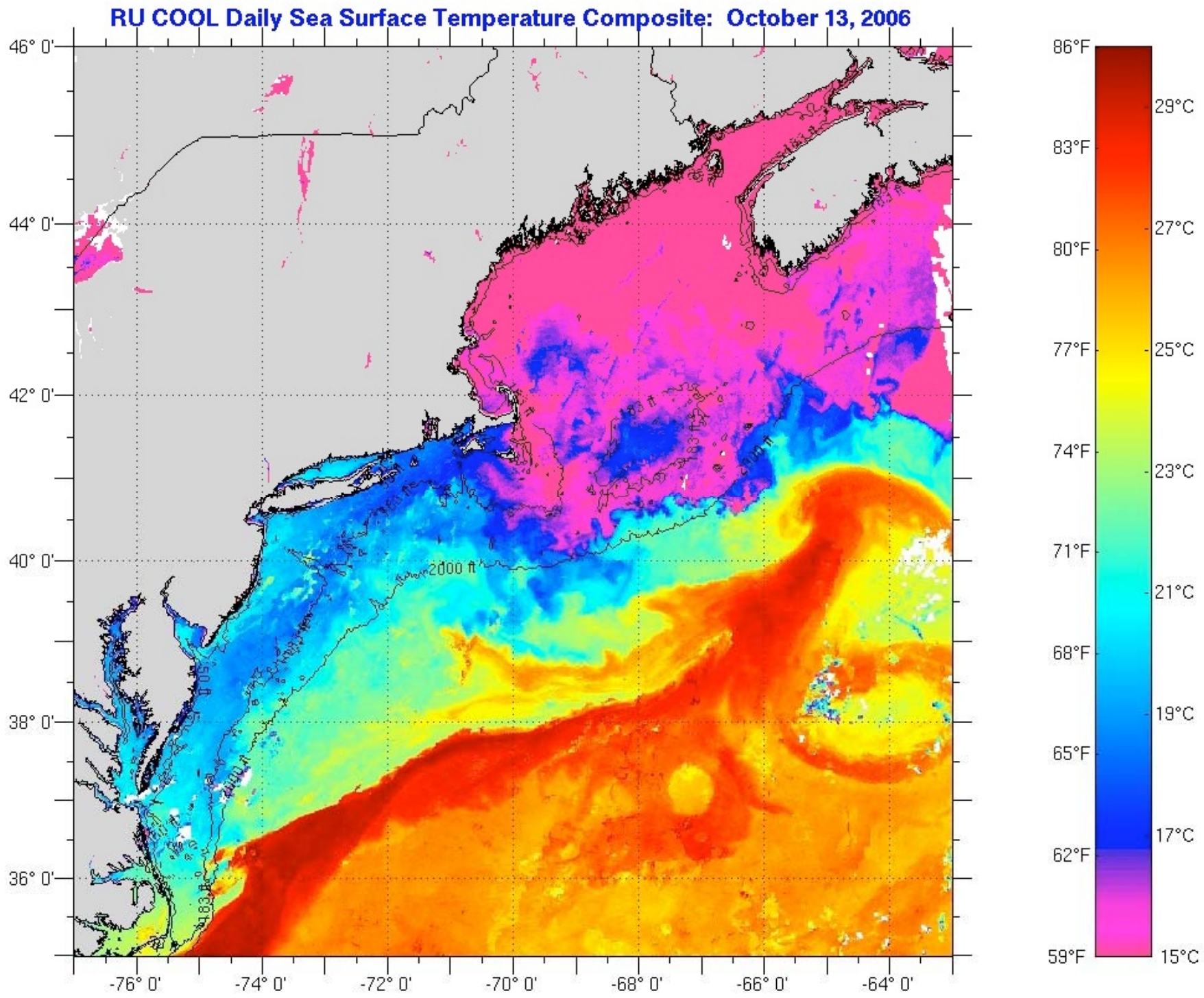
29°C
27°C
25°C
23°C
21°C
19°C
17°C
15°C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42° 0'
40° 0'
38° 0'
36° 0'
-76° 0'
-74° 0'
-72° 0'
-70° 0'
-68° 0'
-66° 0'
-64° 0'
2000 ft
86°F
83°F
80°F
77°F
74°F
71°F
68°F
65°F
62°F
59°F
29°C
27°C
25°C
23°C
21°C
19°C
17°C
15°C

RU COOL Daily Sea Surface Temperature Composite: November 11, 2006