NOAA FISHERIES
Northeast Fisheries Science Center

Contact: Shelley Dawicki
508-495-2378
shelley.dawicki@noaa.gov

January 13, 2016
SS16.01

Northwest Atlantic Ocean May Get Warmer, Sooner

High-resolution global climate model shows much faster warming and changing ocean circulation

A new study by NOAA researchers suggests future warming of ocean waters off the Northeastern U.S. may be greater and occur at an even faster rate than previously projected.

Their findings, based on output from four global climate models of varying ocean and atmospheric resolution, indicate that ocean temperature in the U.S. Northeast Shelf is projected to warm twice as fast as previously projected and almost three times faster than the global average. The models were developed at NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) in Princeton, New Jersey.

"We looked at four GFDL models and compared their output to ocean observations in the region. The highest resolution GFDL model, CM2.6, matched the Northwest Atlantic circulation and water mass distribution most accurately," said Vincent Saba, a NOAA fisheries scientist and lead author of the study. "Prior climate change projections for the region may be far too conservative."

Over the past ten years, the Gulf of Maine has warmed faster than 99% of the global ocean. Recent studies indicate that the enhanced warming is associated with a northerly shift in the Gulf Stream. Changes in the distribution and species composition are already evident, but existing climate change projections are based on warming scenarios from coarse resolution models. Warming of 3 to 4 degrees C (as much as 5.4 to 7.2 degrees F), projected by NOAA GFDL's CM2.6, will likely cause more extreme effects on the ecosystem.

Global climate models used to project global and regional climate change generally have coarse ocean and atmospheric resolution. The higher resolution model better reflects the ocean circulation and sea floor bathymetry in smaller, complex areas like the Gulf of Maine and the U.S. Northeast Shelf. According to the study, the models project that ocean warming will be even more pronounced than suggested by coarser models under increasing concentrations of atmospheric CO_2.

The study appears in the *Journal of Geophysical Research - Oceans*, published by the American Geophysical Union.

The global climate models assessed by the Intergovernmental Panel on Climate Change (IPCC), which are used to project global and regional climate change, are coarse resolution models based on a roughly 100-kilometer or 62-mile grid, to simulate ocean and atmospheric dynamics. NOAA GFDL's CM2.6 offers ten times more resolution by using a roughly 10-kilometer or 6.2-mile ocean grid.

"It is like comparing an old standard definition television screen to today's ultra high definition screens," said Saba, a member of the Northeast Fisheries Science Center's Ecosystem Assessment Program who works at GFDL. "There aren't many high resolution global climate models available due to their prohibitive cost. For much of the global ocean the coarser resolution is okay, but when you are studying a unique location like the Gulf of Maine, with its complex bathymetry of deep basins, channels, and shallow banks combined with its location near the intersection of two major ocean current systems, the output from the coarser models can be misleading."

A warm bias in sea surface temperature in most global climate models is due to a misrepresentation of the coastal separation position of the Gulf Stream, which extends too far north of Cape Hatteras, North Carolina. The model bias, known as the "Gulf Stream separation problem," is a result of the models' coarse resolution. As a consequence of that bias, existing climate change projections for the Northeast U.S. Shelf and the Gulf of Maine are based on unrealistic regional ocean circulation patterns. NOAA GFDL's highest resolution model, CM2.6, significantly reduces that bias.

The study also found that the warming of the upper 300 meters (roughly 1,000 feet) of the Northwest Atlantic increases salinity due to a change in water mass distribution related to a retreat of the colder, fresher Labrador Current and a northerly shift of the warmer, saltier Gulf Stream. Observations and the high-resolution climate model CM2.6 show a strong relationship between a weakening Atlantic Meridional Overturning Circulation (AMOC) and an increase in the proportion of warm-temperate slope water entering the U.S. Northeast Continental Shelf, primarily through the Gulf of Maine's Northeast Channel.

"These results show the need to improve simulations of basin and regional-scale ocean circulation," said Saba, who will use the CM2.6 model findings for a variety of climate studies on living marine resources in the ecosystem. In addition to Saba and Jonathan Hare from NOAA Fisheries' Northeast Fisheries Science Center, other study authors are affiliated with NOAA's Geophysical Fluid Dynamics Laboratory and the Earth System Research Laboratory in Boulder, Colorado.

# # #

Related links:
Journal of Geophysical Research – Oceans article:
http://onlinelibrary.wiley.com/doi/10.1002/2015JC011346/full
Northeast Fisheries Science Center Climate Change Website:
http://www.nefsc.noaa.gov/ecosys/climate-change
Climate, Fisheries, and Protected Resources:
http://www.fisheries.noaa.gov/stories/2014/03/climate_portal.html

NOAA Fisheries Ocean Adapt Tool:
http://www.nmfs.noaa.gov/stories/2014/12/oceanadapt_trackingfish.htm
Climate and Fisheries: Q &A with a NOAA Scientist:
http://www.fisheries.noaa.gov/stories/2015/01/climate_hare_qa.html
NOAA Fisheries Climate Science Strategy:
https://www.st.nmfs.noaa.gov/ecosystems/climate/national-climate-strategy
NOAA's Geophysical Fluid Dynamics Laboratory: http://www.gfdl.noaa.gov/news-app/story.113