

Sea level variations escalating along eastern Gulf of Mexico coast

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Sunset Beach on Treasure Island in St. Petersburg, Fla., during Tropical Storm Andrea in June 2013. Increases in summer sea water levels over the past two decades along the eastern Gulf Coast may be boosting storm surge heights, causing more erosion on beaches like this one, according to a new study. Credit: Thomas Wahl

Around the globe, sea levels typically rise a little in summer and fall

again in winter. Now, a new study shows that, from the Florida Keys to southern Alabama, those fluctuations have been intensifying over the past 20 years. Summer peaks have been getting higher and winter troughs dipping lower, potentially increasing flooding from hurricanes and stressing delicate ecosystems, the researchers report.

The additional summer increase in sea levels over the past two decades means storm surges can rise higher than previously thought, increasing how much [sea level rise](#) contributes to the flooding risk from hurricanes, according to Thomas Wahl, a postdoctoral researcher from the University of Siegen in Germany who is working at the University of South Florida in St. Petersburg and lead author of the study.

Global sea levels rose by about 5 centimeters (2 inches) from 1993 to 2011 and the newfound trend of summer sea level rise has added approximately 5 centimeters on top of that in the eastern Gulf, the research team reports. Wahl and colleagues from Florida and England published their study last week in *Geophysical Research Letters*, a journal of the American Geophysical Union.

Conversely, an increasingly downward, winter sea level trend along the eastern Gulf Coast has reduced the flood risk from winter storm surges. At the same time, the growing gap in the region between summer and winter sea levels might be disrupting coastal ecosystems adapted to what was once a relatively stable difference between the seasonal sea levels, Wahl said.

The team studied the entire U.S. Gulf Coast but found the trend toward a greater summer-winter difference only along eastern Gulf shores. Seasonal sea levels in the eastern Gulf of Mexico followed a steady cycle from the beginning of the 1900s to the 1990s, increasing in summer and dropping in winter by roughly the same amount year after year. But, starting in the 1990s, sea levels have gotten both higher in the summer

and lower in the winter in the eastern Gulf, causing a significant amplification of the annual cycle, according to the study.

The new work is the first to look at the changes to the sea level cycle for the entire Gulf Coast region in the United States and the first to encounter such a trend, according to Wahl. "This increase over a period of almost 20 years is not found elsewhere in the world," he said.

Wahl and his colleagues discovered the trend in data from a set of 13 tide gauges stretching from Key West at the tip of Florida to Port Isabel on the Texas coast. Nearly all the tide gauges in the eastern Gulf of Mexico, from Key West to Dauphin Island off the coast of Alabama, showed a significant change in sea level cycle from the 1990s onwards. The change in the sea level cycle was not observed in gauges in the western part of the Gulf, stretching from the Louisiana coast down to the Texas border with Mexico.

The 20-year increase in the annual amplitude, or difference between the high summer levels and low winter levels, was 21 percent on average and as high as 30 percent in some locations, according to the study.

For example, in Key West, the annual amplitude of the sea level cycle for the most recent five-year window was 12.4 centimeters (4.9 inches), 4.5 centimeters (1.8 inches) higher than the average amplitude before 1993, when the change in the seasonal sea level cycle started.



Thomas Wahl, left, and Mark Luther, scientists at the College of Marine Science at the University of South Florida, at a tide gauge in St. Petersburg, Fla. Wahl and Luther are co-authors on a recently published study that found the seasonal sea level cycle along the eastern Gulf Coast fluctuated more over the past two decades than it had in previous years based on data from 13 tide gauges along the coast. Credit: Thomas Wahl

In 2013, when Wahl came to Florida on a fellowship to study the Gulf, he started by looking at the tide gauge record in St. Petersburg. The surprise of seeing a significant increase there in the [seasonal cycle](#) during the last few years led him to examine the cycle of the entire U.S. Gulf Coast in the past century.

Although centimeter increases may seem small compared to storm

surges measured in meters, the increase means smaller surges have the potential to inundate low-lying areas and cause erosion, Wahl explained. "These indirect effects on storm surges in addition to the [global sea level](#) rise are often ignored," he said.

On the other hand, the decline in sea levels in the winter that was observed in the eastern Gulf reduces the flood risk associated with winter storm surges. However, changes in sea levels in the winter could throw off, for example, the salt balance in sensitive coastal wetlands, Wahl said.

"Very sensitive ecosystems along the Gulf coast depend on the seasonal cycle," he said. "If there are significant changes in the seasonal cycle then this very likely has an effect" on these ecosystems.

Significant changes in the seasonal cycle might also affect oil spills, although the researchers did not look at this effect, Wahl said. The changes in the seasonal cycle could alter the tides and associated currents, which could in turn influence the mixing of the oil and when it reached land, although the impact would likely be small, he noted.

Unlike global sea level rise, which is driven by temperature and is often cited as an effect of climate change, the annual sea level cycle is driven by a variety of local factors including wind, precipitation, sea level pressure and temperature. The annual cycle varies from region to region, and, until recently, was thought to be constant from year to year. Wahl said it has only been in the past few years that scientists around the world have begun looking at possible changes in regional sea level cycles including in the Baltic Sea, Mediterranean Sea, Chesapeake Bay and the Caribbean.

Coastal engineers need information about baseline sea levels in order to build sea walls to protect coastal communities, said Philip Woodworth, a

scientist at the National Oceanography Centre in Southampton in the United Kingdom, who did not contribute to the study.

"A change in the baseline of 5 centimeters could be an important factor," he said.

Wahl said the changes he and his co-authors saw in the seasonal cycle in the eastern Gulf are driven by changes in air temperature and atmospheric sea level pressure over the past two decades. The researchers found that since 1990, summers have been getting warmer and winters have been getting colder in the region. Atmospheric sea level pressure, which also fluctuates with the seasons, declined more in the summer and increased more in the winter after 1990.

Warmer temperatures and lower [sea level](#) pressure in the summer led to the higher water levels being seen in the eastern Gulf, while the lower winter sea levels were driven by the colder temperatures and higher pressure seen during that season, according to the study.

More information: "Rapid changes in the seasonal sea level cycle along the US Gulf coast from the late 20th century"
[onlinelibrary.wiley.com/doi/10 ... 013GL058777/abstract](https://onlinelibrary.wiley.com/doi/10.1002/2013GL058777/abstract)

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