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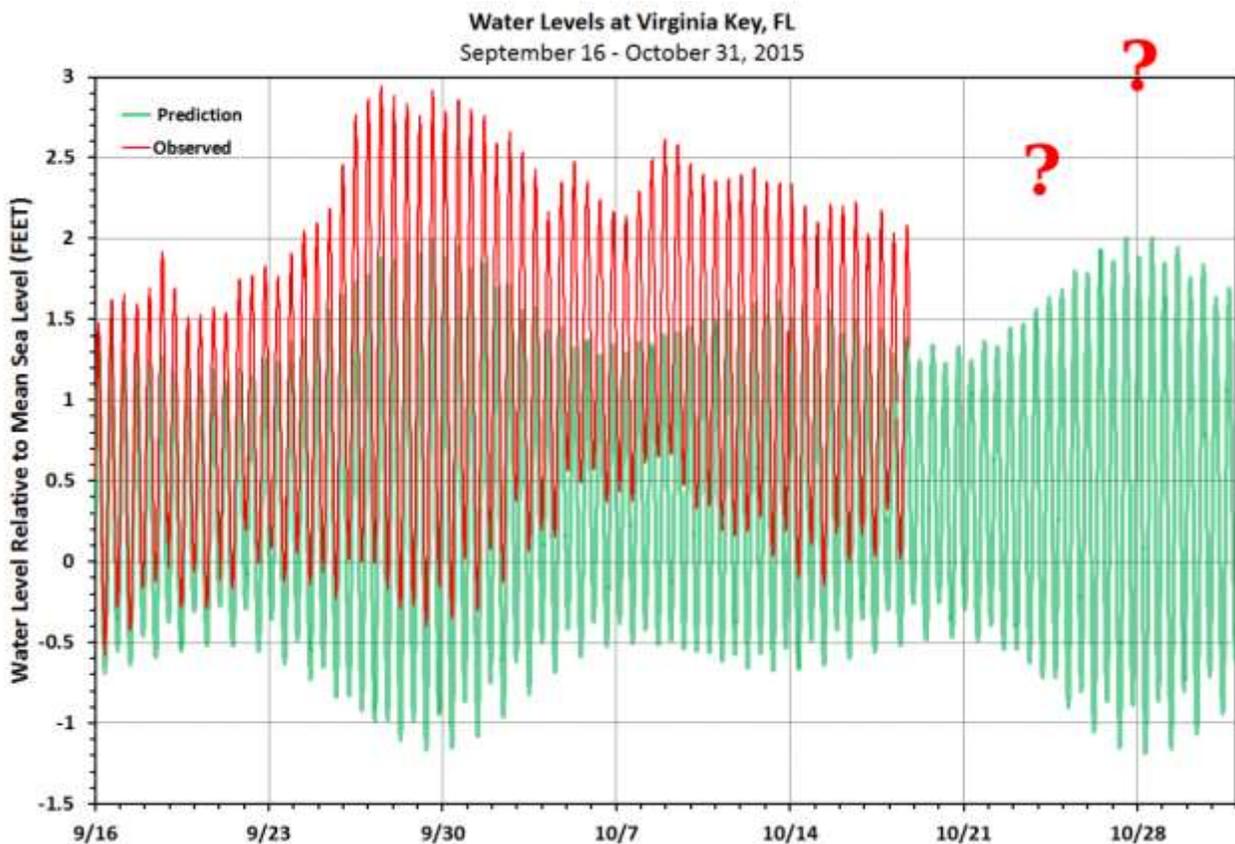
During autumn king tides, nuisance flooding becomes chronic flooding in Miami area

By Brian McNoldy

<https://www.washingtonpost.com/news/capital-weather-gang/wp/2015/10/20/during-autumn-king-tides-nuisance-flooding-becomes-chronic-flooding-in-miami-area/>

King tides. Nuisance flooding. Coastal flood advisory. Road closed. These are phrases that are commonly heard and seen this time of year in the Miami area, especially in low-lying Miami Beach. The highest astronomical tides of the year are coming up in the next couple of weeks, and if these past few are any indication of what's to come, the Miami area could see some of the highest flood levels that have been observed in decades — even on a perfectly sunny day.

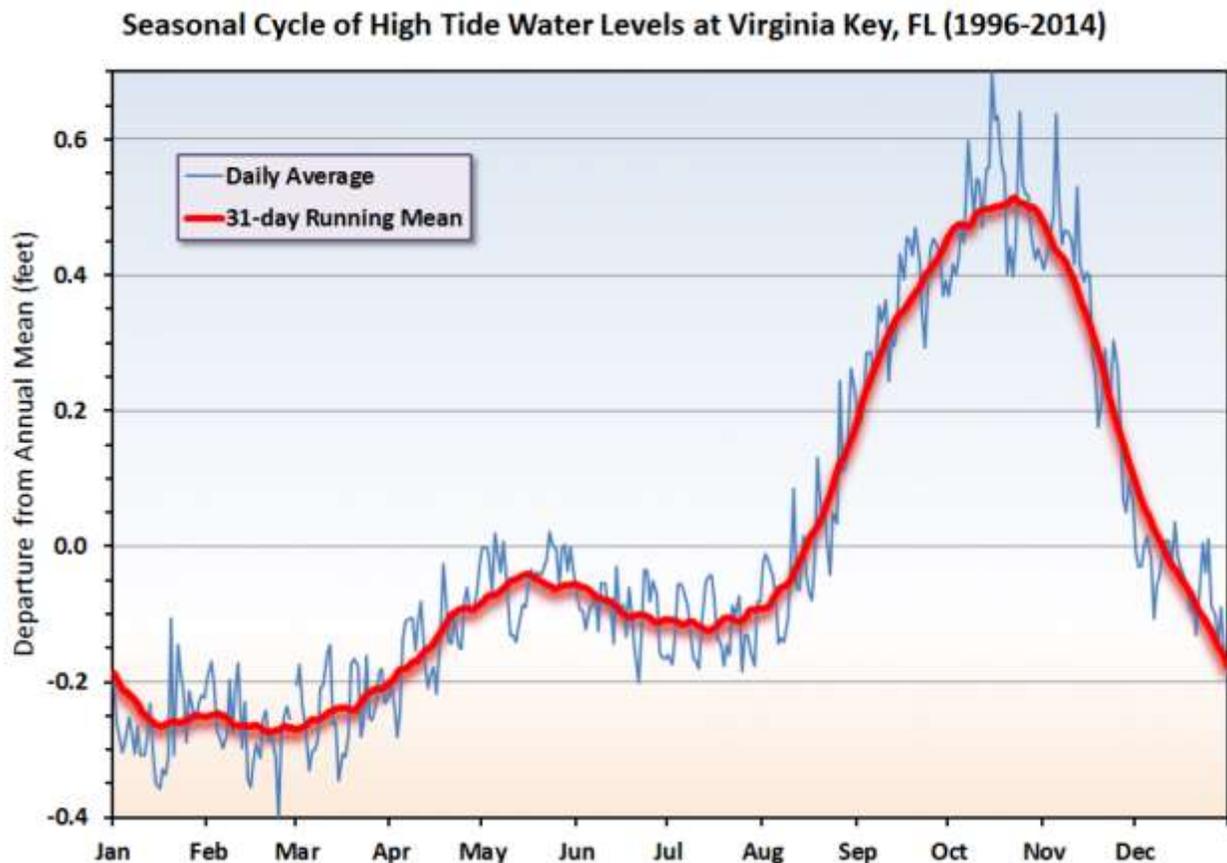
The official water level gauge for the Miami area is located on Virginia Key, a small island east of downtown Miami and south of Miami Beach. Specifically, the gauge is on the end of a dock on the University of Miami's Rosenstiel School campus. It's been the official gauge since 1996.



Predicted (green) and observed (red) water levels at Virginia Key since Sept. 16, 2015.

Actual readings from the Virginia Key gauge have been running anywhere from 6 to 12 inches above the predicted tides since mid-September. This has caused tidal flooding problems day after day in the sensitive, low-lying areas of Miami Beach.

There are a few factors coming together to create this extended period of tidal flooding. First, the tides are naturally highest in September and October here due to predictable seasonal oceanic factors. Specifically, the ocean is warmest at the end of summer, and water expands as it warms. Secondly, the velocity in the Florida Current portion of the Gulf Stream is weakest during October, so water literally piles up along the Florida east coast leading up to that minimum. On average, high tides are about 10 inches higher in October than they are during February. We can count on that every year.



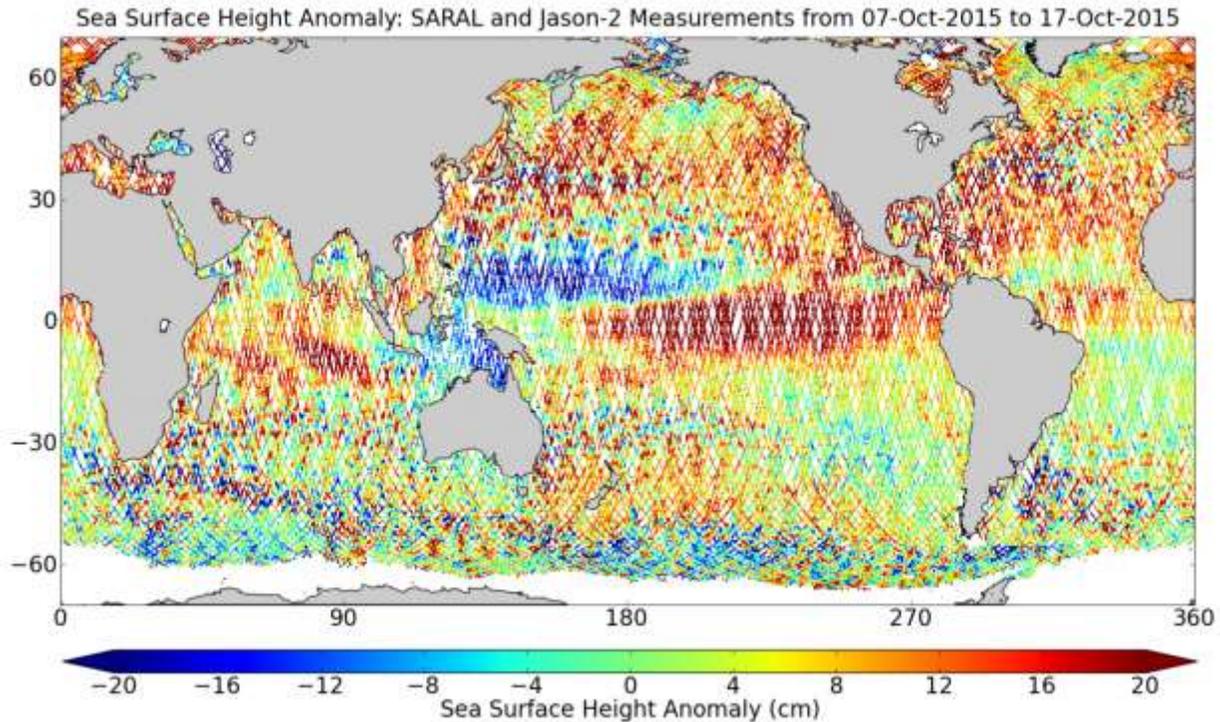
On top of the highest annual tides, water levels are particularly high around the full moon when the gravitational pull on the ocean from the moon and the sun are the greatest. When the highest annual tides coincide with these colloquially termed "king tides," the Miami area historically experiences some degree of tidal flooding.

The whole region is relatively low-lying, and is built on porous limestone, so when the tides are exceptionally high, sea water percolates up through storm drains and the ground.

Lately, satellites that detect variations in the height of the sea surface have observed quite a large departure from normal here, among many other places. The sea level can increase locally for a variety of reasons. If the water is abnormally warm, it will increase the water depth through thermal expansion — water expands as it gets warmer. It can also rise

during persistent low pressure in the atmosphere, which acts to draw the surface of the water upward (high pressure would push water downward). Water levels can rise by about 2 inches for every 5 millibars of low pressure.

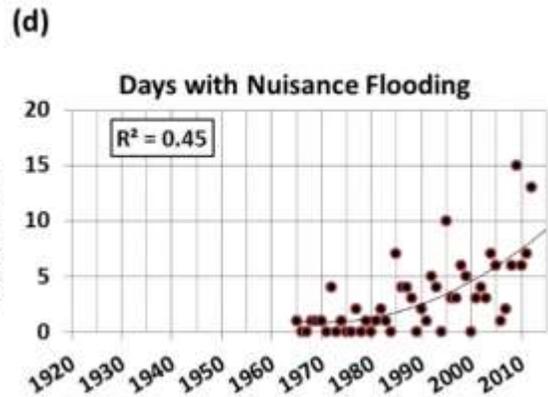
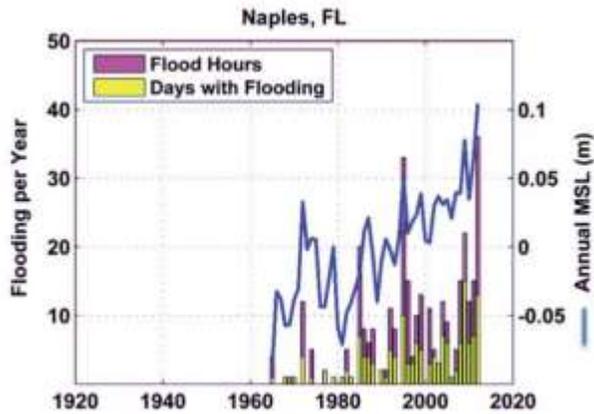
Over the past three weeks or so, we've had a combination of both, which is clearly shown on this map. You can also see a "mountain" of very high water levels in the tropical Pacific, which is evidence to the very warm waters of the ongoing El Niño.



Map of sea surface height anomalies over a 10-day period from October 7-17. (NASA)

And then there's sea level rise, which is not solely responsible for exceptionally high tides, but it does gradually raise the background water levels. Just over the past 20 years, sea level has risen by nearly 4 inches in the Miami area, and by roughly a foot in the past 100 years. Year by year, in a slow-motion crisis, the baseline creeps up — and what's troubling is that the *rate of the increase has been accelerating*.

Each inch of sea level rise makes it easier for high tides to flood areas that never used to flood, and for storm surges to reach places they previously wouldn't have. Sea level rise makes "nuisance flooding" an increasingly common occurrence, to the point where it becomes chronic flooding.

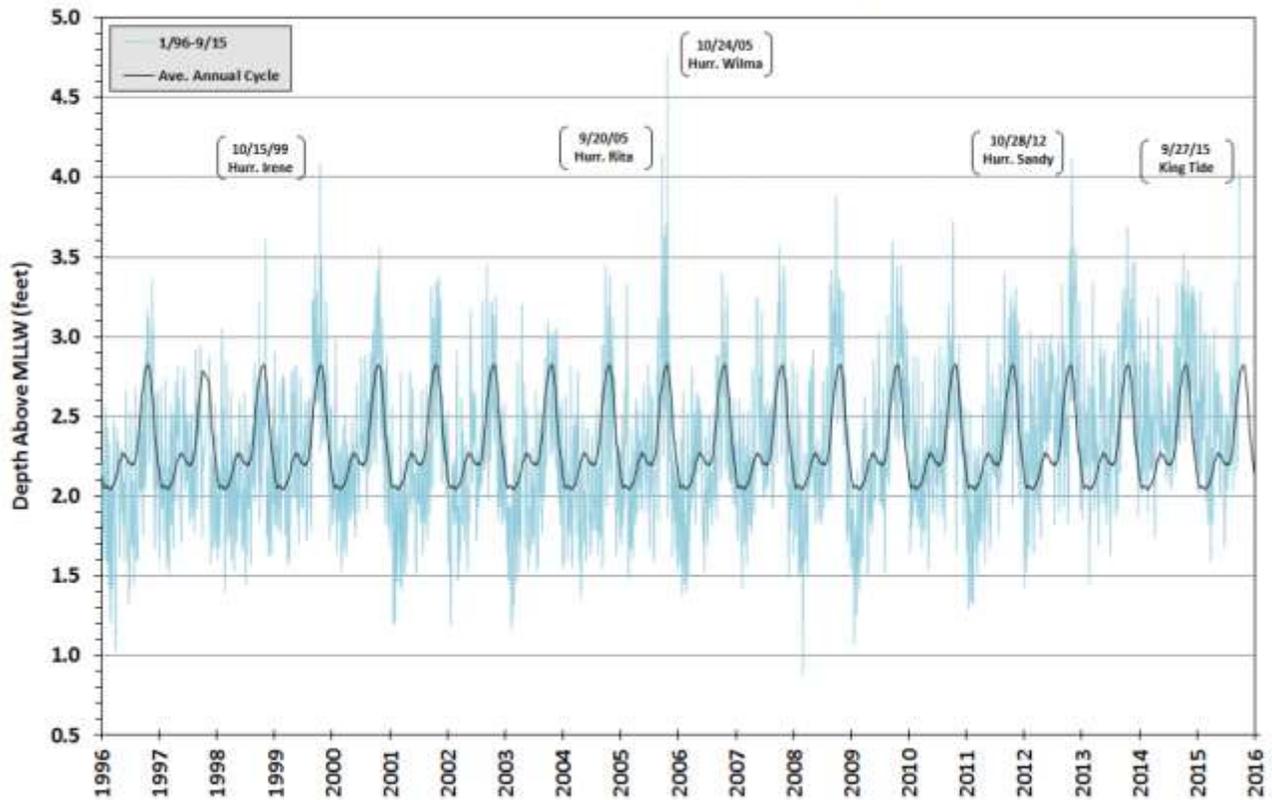


An example of the increasing frequency of “nuisance” flooding events in Naples, Fla. (NOAA)

A fairly notorious contributor to coastal flooding in this area is storm surge during hurricanes. Since records began in 1996 at Virginia Key, the top four high-water events have all been associated with nearby hurricanes, and typically ones that coincided with the September and October king tides.

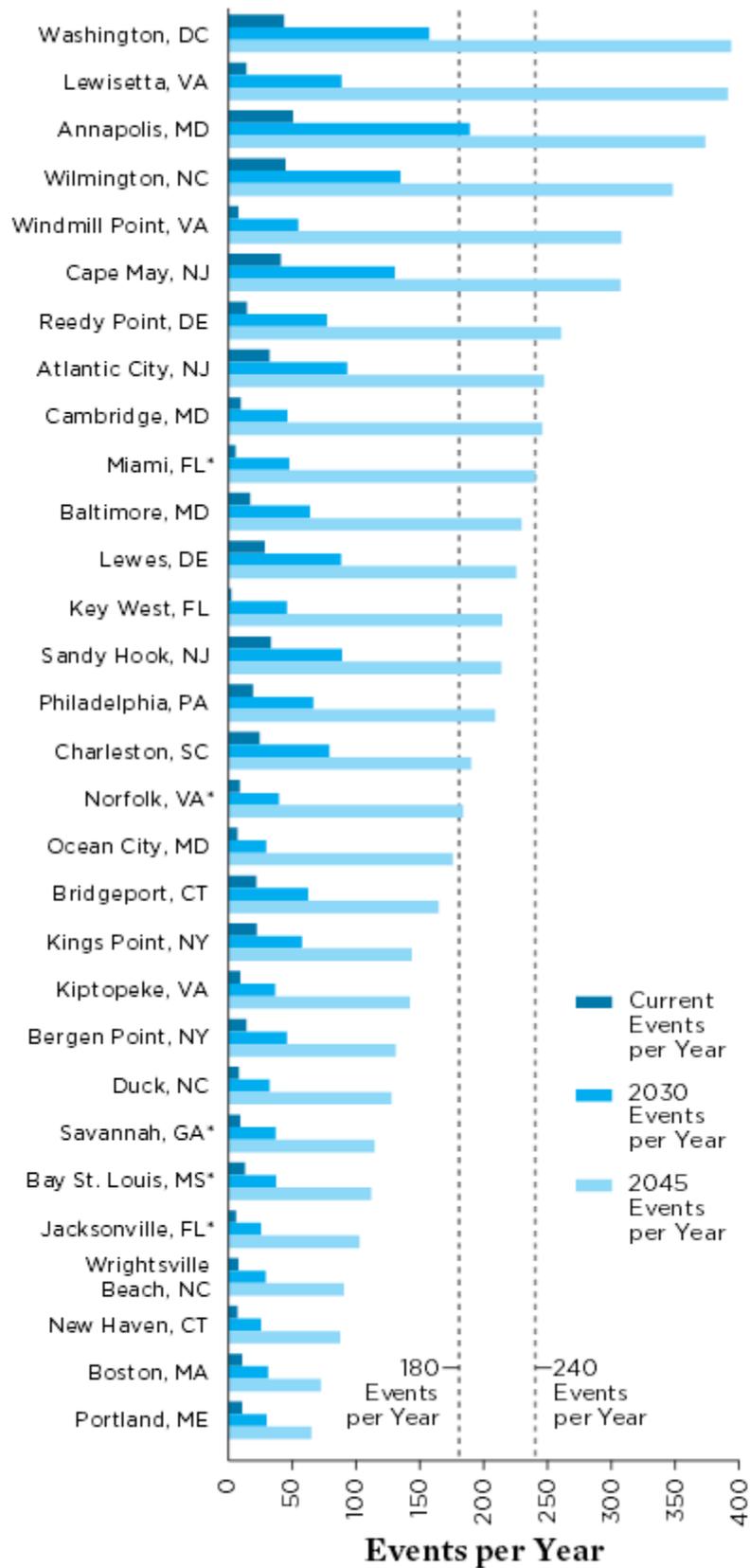
But on Sept. 27, the fifth highest water level was measured at the location, and there was no influence from a hurricane. Will the king tides during the last week of October creep up even further than September’s? It’s possible.

Verified High Water Levels at Virginia Key, FL



Time series of daily high tide water levels at Virginia Key, Fla., (near Miami) from January 1996 through September 2015. The average seasonal cycle is overlaid in black for reference. The top five events are labeled with their dates.

This problem is of course not limited to Miami and Miami Beach. Coastal locations around the globe are facing the same troubles, and that includes the Mid-Atlantic. In fact, according to a report by the Union of Concerned scientists, the Washington, D.C., region is expected to see the largest number of tidal floods each year on the East Coast by 2045. "It can expect nearly 400" per year, they report.



Annual frequency of "nuisance flooding" events today, and in 2030 and 2045. (Union of Concerned Scientists)