Acceleration in sea level rise far larger than initially thought, study shows

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Credit: Tiago Fioreze / Wikipedia

The acceleration in global sea level from the 20th century to the last two decades has been significantly larger than scientists previously thought, according to a new Harvard study.

The study, co-authored by Carling Hay, a post-doctoral fellow in the Department of Earth and Planetary Sciences (EPS), and Eric Morrow, a

recent PhD graduate of EPS, shows that previous estimates of global sea-level rise from 1900-1990 had been over-estimated by as much as 30 percent. The report, however, confirms previous estimates of sea-level change since 1990, suggesting that the rate of sea-level change is increasing more quickly than previously believed. The new work is described in a January 14 paper published in *Nature*.

"What this paper shows is that sea-level acceleration over the past century has been greater than had been estimated by others," Morrow said. "It's a larger problem than we initially thought."

"Scientists now believe that most of the world's ice sheets and mountain glaciers are melting in response to rising temperatures." Hay added. "Melting ice sheets cause global mean sea level to rise. Understanding this contribution is critical in a warming world."

Previous estimates had placed sea-level rise at between 1.5 and 1.8 millimeters annually over the 20th century. Hay and Morrow, however, suggest that from 1901 until 1990, the figure was closer to 1.2 millimeters per year. But everyone agrees that global sea level has risen by about 3 millimeters annually since that time, and so the new study points to a larger acceleration in global sea level.

"Another concern with this is that many efforts to project sea-level change into the future use estimates of sea level over the time period from 1900 to 1990," Morrow said. "If we've been over-estimating the sea-level change during that period, it means that these models are not calibrated appropriately, and that calls into question the accuracy of projections out to the end of the 21st century."

To obtain their improved estimate of 20th century global sea level, Hay and Morrow approached the challenge of estimating sea-level rise from a completely new perspective.

Typically, Hay said, estimates of sea-level rise are created by dividing the world's oceans into sub-regions, and gathering records from tide gauges - essentially yard-sticks used to measure ocean tides - from each area. Using records that contain the most complete data, researchers average them together to create estimates of sea level for each region, then average those rates together to create a global estimate.

"But these simple averages aren't representative of a true global mean value" Hay explained. "Tide gauges are located along coasts, therefore large areas of the ocean aren't being included in these estimates. And the records that do exist commonly have large gaps."

"Part of the problem is related to the sparsity of these records, even along the coastlines," Morrow said. "It wasn't until the 1950s that there began to be more global coverage of these observations, and earlier estimates of global mean sea-level change across the 20th century were biased by that sparsity."

"We know the sea level is changing for a variety of reasons," Hay said. "There are ongoing effects due to the last ice age, heating and expansion of the ocean due to global warming, changes in ocean circulation, and present-day melting of land-ice, all of which result in unique patterns of sea-level change. These processes combine to produce the observed global mean sea-level rise."

The new estimates developed by Hay and Morrow grew out of a separate project aimed at modeling the physics that underpin sea-level "fingerprints" - explainer from previous story.

"What we were interested in - and remain interested in - was whether we can detect the sea-level fingerprints we predicted in our computer simulations in sea-level records," Morrow said. "Using a global set of observations, our goal has been to infer how individual ice sheets are

contributing to global sea-level rise."

The challenge, Hay said, is that doing so requires working with a "very noisy, sparse records."

"We have to account for ice age signals, and we have to understand how ocean circulation patterns are changing and how thermal expansion is contributing to both regional patterns and the global mean," she explained. "We try to correct for all those signals using our simulations and statistical methods, then look at what's left and see if it fits with the patterns we expect to see from different ice sheets."

"We are looking at all the available sea-level records and trying to say that Greenland has been melting at this rate, the Arctic at this rate, the Antarctic at this rate, etc." she continued. "We then sum these contributions and add in the rate that the oceans are changing due to thermal expansion to estimate a rate of global mean sea-level change."

To their surprise, Hay said, it quickly became clear that previous estimates of sea-level rise over most of the 20th century were too high.

"We expected that we would estimate the individual contributions, and that their sum would get us back to the 1.5 to 1.8 mm per year that other people had predicted," Hay said. "But the math doesn't work out that way. Unfortunately, our new lower rate of sea-level rise prior to 1990 means that the sea-level acceleration that resulted in higher rates over the last 20 years is really much larger than anyone thought."

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