Salt marsh sediments help gauge climate-change-induced sea level rise

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A newly constructed, 2,000-year history of sea level elevations will help scientists refine the models used to predict climate-change-induced sea level rise, according to an international team of climate researchers. The record also shows that the past century had the fastest recorded rate of sea level rise.

"One of the largest uncertainties in projecting the impacts of climate change involve predicting the amount and rate of future sea level rise," said Michael E. Mann, professor of meteorology, Penn State. "The societal ramifications are as great as any climate change impact, but, because the uncertainties are particularly large due to limitations in the representations of some key processes, such as ice sheet collapse, in existing models, we still do not know how sea level will rise."

To create the sea level timeline, the researchers examined sediment cores from salt marshes in North Carolina to create an unbroken record of sea level through time. They used the remains of foraminifera, tiny plankton-like creatures that live in the oceans, to determine sea level. Because different species of foraminifera live at different depths in the oceans, a survey of the types of remains will tell researchers how deep the ocean was in that particular spot at the time the sediment layer was laid down. Careful dating of the layers provides a timeline of sea level changes. The researchers reported their findings in today's (June 20) online version of the Proceedings of the National Academy of Sciences.

Combining the sea level changes through time with the already established temperature record for the past 1,000 years, the researchers created a model, partly based on observations, that matches what happened historically and can be used to predict future changes in sea level.

One problem with current model estimates of sea level rise is that they do not account for all of the potentially important processes. The simulations cited by the Intergovernmental Panel on Climate Change for its 2007 report did not include the effects of ice melting from glaciers in Greenland and Antarctica.

"Prior to the past few decades there was no obvious contribution from melting ice sheets," said Mann. "It is only over the past five years or so that we have clear evidence that the ice sheets are losing mass. Prior to that they appear to have been stable as far back as the end of the last ice age."

Because the sea level model in the current study is based on observations, it includes -- in principle -- all of the relevant processes, including the contribution from melting ice sheets, mountain glaciers and the expansion of seawater with increased temperatures.

The researchers chose North Carolina salt marshes for their sediment samples because the area is relatively free of impacts related to the slow rebounding of the Earth's surface from the weight of the ice sheet that covered parts of North America during the last ice age. This minimized the necessary adjustments for the rebound.

"The temperature and sea level reconstructions were determined independently from each other, and yet each shows what we would expect based on the other," said Mann. "Higher temperatures correspond with higher rates of sea level change and vice versa."

From 100 B.C. to A.D. 950, the researchers found sea level stable in North Carolina. From 950 to 1400, sea level rose at a rate of a bit over 0.02 inch per year due to the relative warmth during the Medieval Period. From 1400 until about, sea level was again stable due to the effects of the Little Ice Age. The rate of rise from 1880 through 1920 in North Carolina was 0.08 inch a year.

"This historical rate of rise was greater than any other persistent, century-scale trend during the past 2,100 years," the researchers report.

Provided by Pennsylvania State University