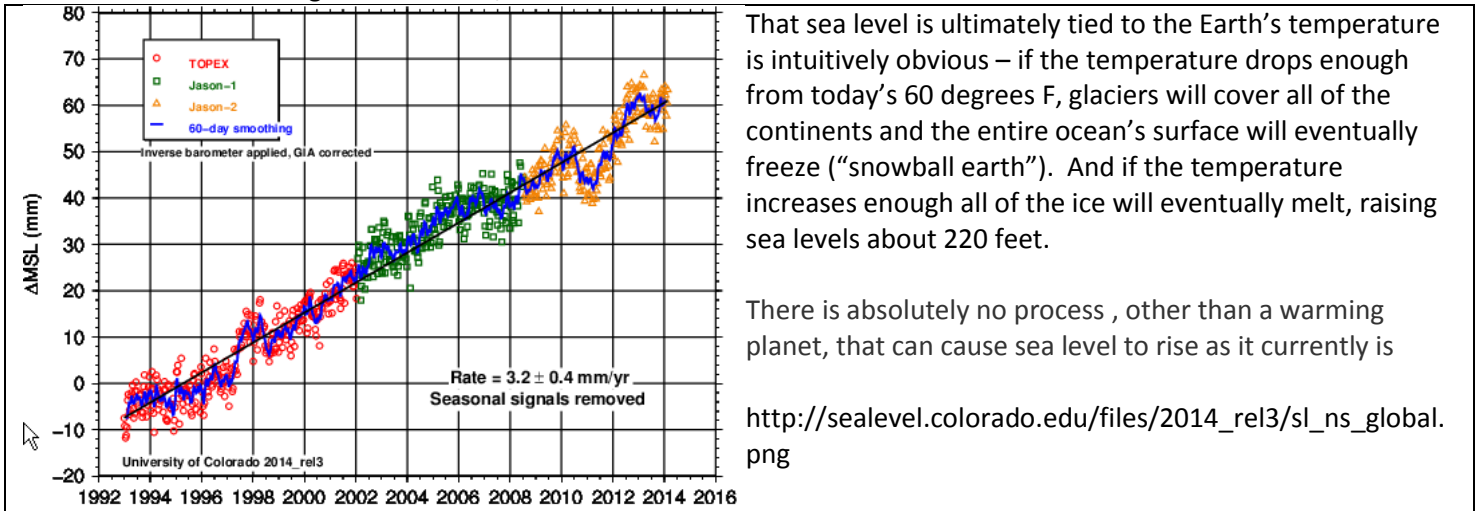


Current sea level is rising about 3.2 mm/hear



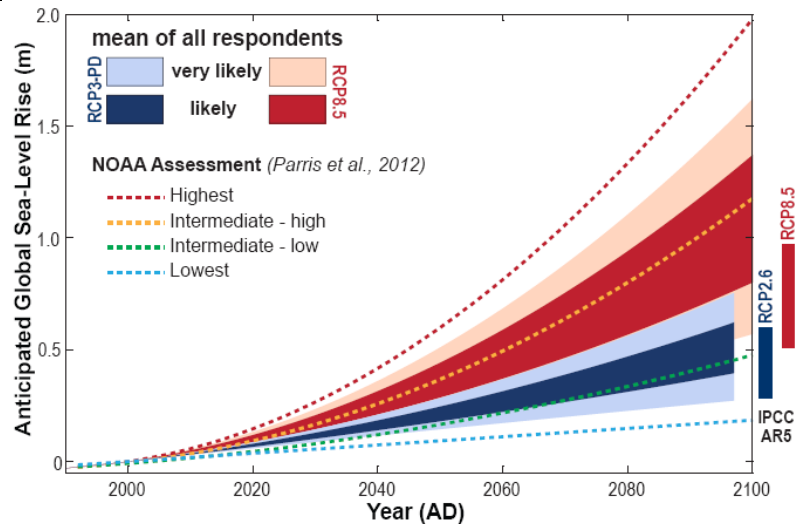
Because the earth is warming, sea levels are rising. Climate scientists have predicted that the sea levels will rise by three to six feet by the year 2100, and perhaps a foot a decade after that. How much the seas will eventually rise depends on the total amount of CO2 that humans emit, as the CO2 is the driver of the Earth’s temperature, which is, in turn, the driver of the equilibrium sea level. But no line of evidence suggests that sea level rise will eventually be less than 10 feet per degree F. Since there is almost no chance that the Earth’s equilibrium temperature increase will be less than 4°F, equilibrium sea level rise will likely be at least 60 feet (and could be as 100 feet)

	Atmospheric CO2 (PPM)	Temperature Difference from 1870	Sea Level Increase (feet)	Seal Level Rise (feet/°F) (Rounded)
Pliocene (3-5 million years ago)	400	3-5	80	15-25
Last Ice Age		14	400	30
“Combined paleoclimate data”	400	3-5 ¹	100	20-30
Models		4	40	10
If all the ice melts		11	220	20
Likely Minimum		4	60	15

1. Estimated based on Pliocene

Expected Sea Level Rise This Century

"In the long run, sea-level rise will be one of the most serious consequences of global warming. But how fast will sea levels rise? Model simulations are still associated with considerable uncertainty – too complex and varied are the processes that contribute to the increase. A just-published survey of 90 sea-level experts from 18 countries now reveals what amount of sea-level rise the wider expert community expects. With successful, strong mitigation measures [RCP2.6], the experts expect a likely rise of 40-60 cm in this century and 60-100 cm by the year 2300. With unmitigated warming [RCP8.5], however, the likely range is 70-120 cm by 2100 and two to three meters by the year 2300." (http://www.realclimate.org/index.php/archives/2013/11/sea-level-rise-what-the-experts-expect/?wpmc_tp=1#sthash.6PKwYWsx.dpuf - 23 November 2013)



Climate Change Will Be 'Catastrophic' by 2100, Raising Sea Levels By 'Many Meters,' According To New Study <http://www.isciencetimes.com/articles/6609/20131231/climate-change-catastrophic-2100-7-2-degrees-global-warming.htm>

Part of the East Antarctic ice sheet may be less stable than anyone had realized, researchers based in Germany have found. Writing in *Nature Climate Change*, two scientists from the Potsdam Institute for Climate Impact Research (PIK) say the melting of quite a small volume of ice on the East Antarctic shore could ultimately trigger a discharge of ice into the ocean which would result in unstoppable sea-level rise for thousands of years ahead. <http://www.nature.com/nclimate/journal/vaop/ncurrent/full/nclimate2226.html>

Climate change models underestimate likely temperature rise, report shows <http://www.theguardian.com/science/2014/jan/01/climate-change-models-underestimate-likely-temperature-rise-report-shows>

Expected Equilibrium Sea Level Rise Based On Paleoclimate Data

In planning for a future when the Earth will be significantly warmer than it is today, it is helpful to look at what occurred in the past when temperatures and atmospheric CO₂ concentrations were similar to what we can expect this century. One can hope that the sea level rise will be on the low end of what happened previously, but a prudent planner would look at the middle-to-upper end of historical sea levels when atmospheric CO₂ was at 450ppm and temperatures were 2-3 degrees C warmer than it was in pre-industrial times.

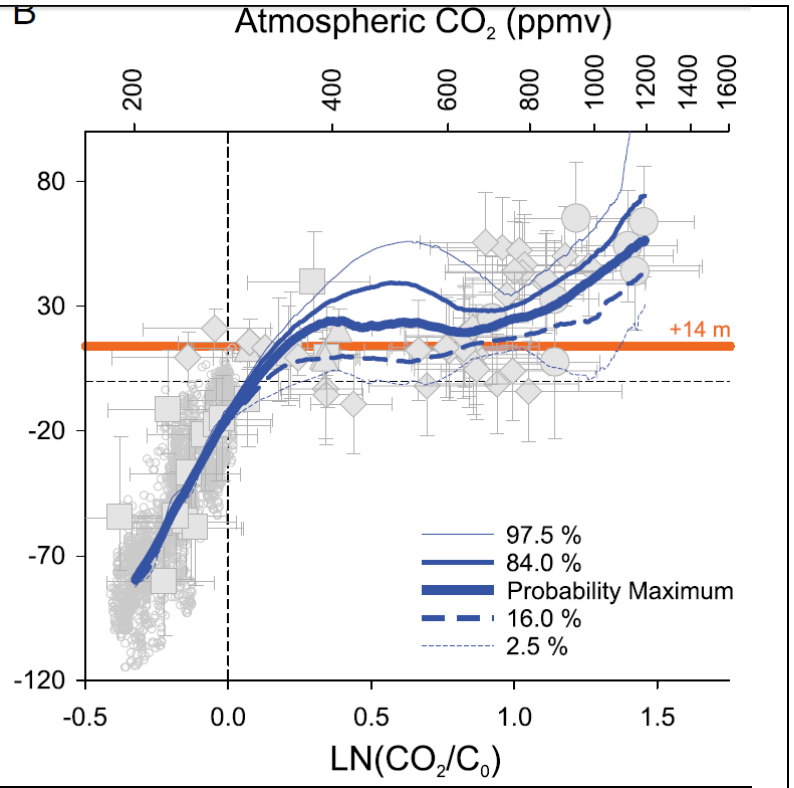
Pliocene

The last time CO₂ levels were around 400 ppm (which is where they are now) was some 3 to 5 million years ago during the Pliocene (at which time the concentrations were on the way down). Scientists estimate that global sea level during the Pliocene was anywhere between 30 and 90 feet higher than it is today. (<http://blogs.ei.columbia.edu/2013/06/11/400-ppm-world-part-1-large-changes-still-to-come/>)

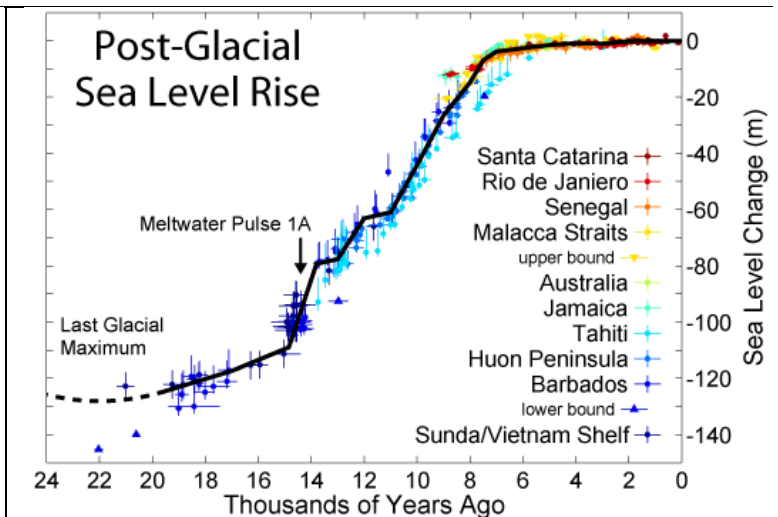
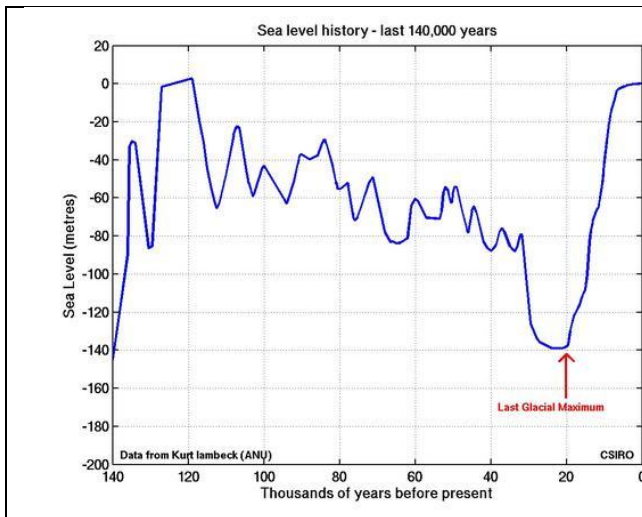
Relationship between sea level and climate forcing by CO2 on geological timescales

Fig. 3. Cross-plot of estimates of atmospheric CO₂ and coinciding sea level... (B) Results from our probabilistic analysis of the data that fully accounts for uncertainty in both X and Y parameters ... dotted lines denote the preindustrial conditions of 0 m and 280 ppm CO₂. The horizontal orange line shows +14 m, which is the sea-level rise associated with the total melting of WAIS and GrIS (31). (WAIS= West Antarctic Ice Sheet, GrIS=Greenland Ice Sheet)
Gavin L. Foster and Eelco J. Rohling, Sept 2012 - <http://www.pnas.org/content/early/2013/01/03/1216073110.abstract>

Based on this graph, we should plan for a long-term sea level rise of over 30 meters (90 feet) due to the CO₂ that is currently in the atmosphere (400 PPM). With sea levels currently rising at rate of about 1 foot/80 years, such a large increase seems questionable, but if one looks at the paleoclimate record and the modeling of expected long-term sea level rise, that number makes sense.



Expected Equilibrium Sea Level Rise Based On The Last Ice Age



At the end of the last ice age sea levels rose about 30 feet per degree F of temperature increase (400 feet of sea level rise for a 14 degree F increase in temperature). It is reasonable to assume that the rate will be at least 20 feet/degree F over long time periods. If the temperature increases 4 degrees F (which is very likely), we should expect an eventual sea level rise of at least 80 feet.

Expected Equilibrium Sea Level Rise Based On Climate Models

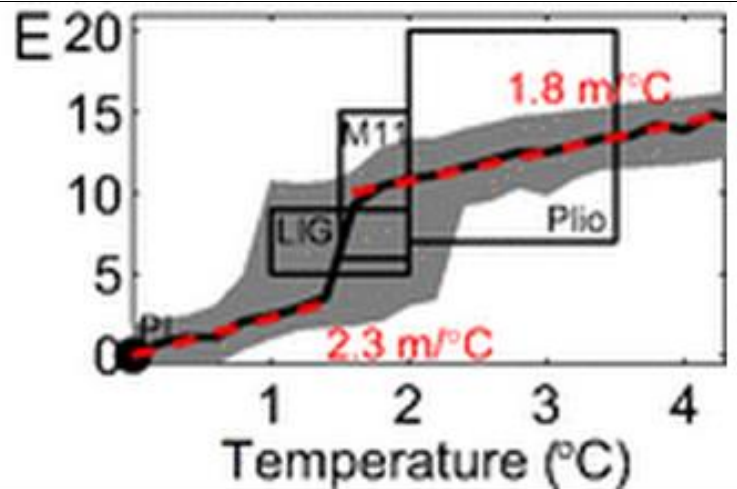
James Hansen has suggested that it would take a temperature increase of about 11° F to melt all existing ice (resulting in an average of about 20 feet/° F)

“The multimillennial sea-level commitment of global warming” [Anders Levermann](#) et al, June 2013 PNAS

“Here we combine paleo-evidence with simulations from physical models to estimate the future sea-level commitment on a multimillennial time scale and compute associated regional sea-level patterns. “

Meters of sea-level rise plotted against temperature increase. Note that a 2.5 °C temperature increase will likely result in 10-15 meters (30-45 feet) of sea level rise. And even with a 2 °C temperature increase the sea level rise will likely be 10 meters (30 feet)

<http://www.pnas.org/content/110/34/13745.full>



The ... total sea-level commitment, which is consistent with paleo-estimates from past warm periods (the left axis in meters)

Figure 7 – Expected sea level rise for changes in atmospheric CO2 and temperature

Sea level if all of the ice melts



High Tide on Main Street: (<http://www.johnenglander.net/book>)

Rising Sea Level and the Coming Coastal Crisis

By John Englander; Foreword by Jean-Michel Cousteau

(Publisher: The Science Bookshelf; ISBN 978-0615637952. Suggested retail \$19.95)

Englander's new book "High Tide On Main Street: Rising Sea Level and the Coming Coastal Crisis" is a radically different point of view to understand sea level cycles. It explains how they are changing and why no one yet sees the giant, tsunami-like wave that will hit over the next hundred years and beyond. During the next decade this ultra long-term threat will become as real the devastation that occurred in Japan in 2011.

While the physical impacts of sea level rise will be on the order of another inch this decade—hardly discernible—what will start to change will be the perception of coastal real estate values. Most importantly, a new perspective will emerge on how to begin "intelligent adaptation"—a true mindset shift that will last for centuries.

High Tide On Main Street: Rising Sea Level and the Coming Coastal Crisis

- Uses simple graphics and metaphors to explain the big picture of sea level rise, without technical talk or jargon. Covers the surprising forces; historical perspective of regular rise and fall of more than 400 feet; and realistic ranges for increase by 2050 and 2100, and beyond.
- Explains why sea level will rise for at least 500 years regardless of our efforts to limit global warming.
- Looks at sea level rise apart from the broader issues of climate change. Rising sea level is special in that it is easy to visualize, unambiguous and will have huge financial impacts globally on homeowners, cities, businesses, and nations.
- Shows how sea level rise is much more urgent than is currently being reported in the media. Coastal property prices could start being "discounted" in the next decade long before they actually go underwater. This will lead to the destruction of trillions of dollars of assets.
- Examines the limitations of seawalls and other efforts to hold back the sea, which is now rising faster and faster. While they may work for a limited time, they may be a bad investment. Where can we look for a good "ROI" (return on investment)—as individuals, as businesses, and as communities. Some surprising opportunities lie ahead—amid the chaos and value destruction.
- Stresses the importance of intelligent adaptation.

The aim of the book is to clearly explain the geologic timescale, the forces, and the probability of what will happen this century. With that understanding, readers can:

- Protect the assets of family and friends, before the devaluation starts.
- Encourage community and government leaders to plan for realistic sea level rise of at least several feet this century. Beyond the loss of valuable property, profound damage may affect transportation and utility infrastructure, harbors, sewage treatment, ground water sources, and more.
- Be alert to one specific location and type of event that would virtually announce catastrophic levels of sea level rise, far greater than the present forecast: the so called "doomsday scenario".
- In addition to preparing one's personal assets and encouraging communities to be better prepared, the book recommends positive efforts at the community and government level:
- The one change in public policy that can ultimately slow the rise in sea level.
- How we need to begin thinking clearly and creatively about "adaptation" to the changes that will start happening by mid-century or sooner. Innovative large-scale civil engineering projects can improve the otherwise disastrous situation ahead, and can also create jobs and positively contribute to our economy.