

## Climate Models and Common Sense - Sea Level Rise

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[http://ccdatacenter.org/documents/ClimateModelsandCommonSense\\_SeaLevelRise.pdf](http://ccdatacenter.org/documents/ClimateModelsandCommonSense_SeaLevelRise.pdf)

There appears to be a wide disparity between some important forecasts by climate models and common sense. The problem may be that the IPCC forecasts depend on models to predict the future sea level rise and these models incorporate only those physical processes that climate scientists understand (i.e., what they don't understand they can't model). For example, in 2013 the IPCC predicted, with *medium confidence*, 1- 2 feet of sea level rise by 2100 for a low emissions scenario (RCP 2.6) based on climate models that were developed before 2011, and no mention was made of the expected equilibrium sea level rise. In addition, the IPCC has not adjusted the amounts as new data become available, as they publish their reports roughly every five years. But the expectation for sea level rise is now between 2.5 and 6.5 feet by 2100 because of a better understanding of ice sheet dynamics, and even these latest estimates may be too low. In addition, very little mention is made of the expected *equilibrium* sea level rise, so most people have no idea that catastrophic sea level rise is already "locked in" – a question of "when" not "if". By taking a closer at paleoclimate data (see Table 1 below), the following might be a good way to describe the expected sea level rise:

Based on paleoclimatic data, we should expect an equilibrium sea level rise in excess of 60 feet if the global temperature can be limited to a 2°C increase since preindustrial times. Our climate models cannot accurately predict how fast the sea level will rise in the coming years, but since temperatures are currently increasing about 20 times as fast as they were coming out of the last ice age and since the seas were then rising about 0.4 inches/year, a reasonable estimate of sea level rise in about 100-150 years is about an inch/year. For planning purposes it seems reasonable to expect that sea levels will rise about 1-2 feet by 2050, 3-7 feet by 2100, 15-30 feet by 2200, and about 60 feet at equilibrium. (A rise of 30 feet by 2200 equates to an average of 1.8 inches/year, roughly three times the rate from 11,000 to 8,000 years ago.)

Expected Sea Level Rise Based on Past Sea Levels		
1	15 meters/° C	Sea level rise coming out of the last ice age
2	10-20 meters/° C	Sea level rise over geologic time
3	12-18 meters/° C	Sea level rise if all ice melts for a 4-6° C temperature increase
Equilibrium Sea Level Rise to Plan On (for at least 2° C of warming)		
4	20 meters	It will likely be more than this
Expectations for sea level rise by 2100		
5	0.28–0.61 meters	IPCC
6	0.8-2 meters	Recent analysis
7	1.3 meters	If the sea level rises 2.35%/year (it has been almost linear) (rising at about .3 meters per decade – almost an inch/year – in 2100)
Rates of historical sea level rise		
8	.39 inches/year	Coming out of the last ice age - average
	.60 inches/year	Coming out of the last ice age - 11,000 to 8,000 years ago
9	.133 inches/year	1993-2015
Rates of historical temperature change		
10	.008 ° C/decade	18,000 – 8,000 years ago
11	.17° C/decade	1976-2015

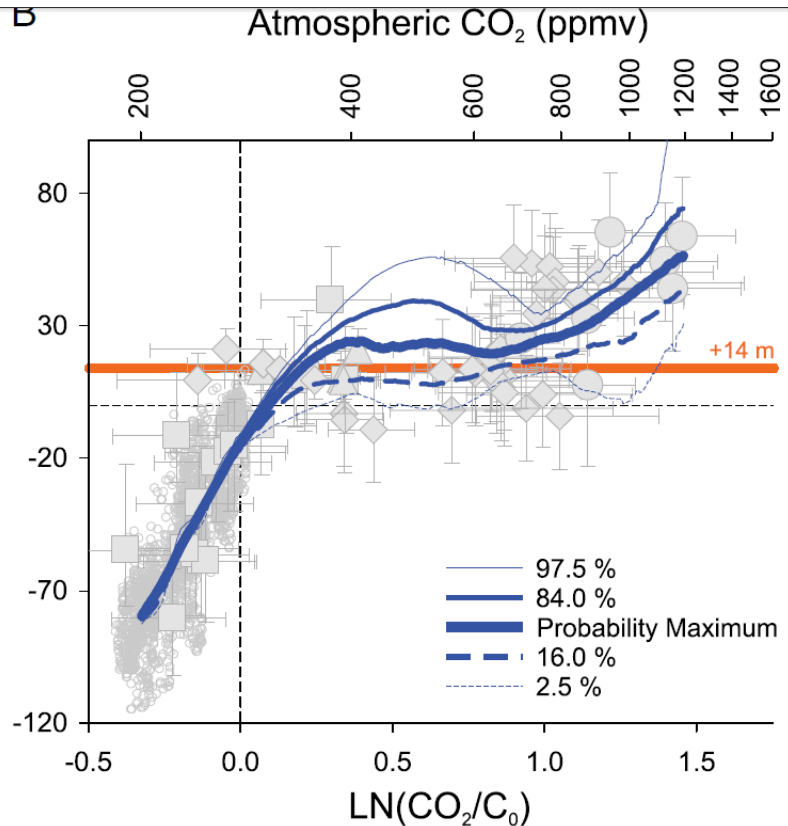
Table 1 – Sea Level Rise Measurements (see corresponding footnotes for sources)

Footnotes

<p>1</p>	<p>Post-Glacial Sea Level Rise</p> <p>Sea Level Change (m)</p> <p>Thousands of Years Ago</p> <p>Meltwater Pulse 1A</p> <p>Last Glacial Maximum</p> <p>Santa Catarina Rio de Janeiro Senegal Malacca Straits upper bound Australia Jamaica Tahiti Huon Peninsula Barbados lower bound Sunda/Vietnam Shelf</p> <p><a href="http://ossfoundation.us/projects/environment/global-warming/myths/images/sea-level/Post-Glacial_Sea_Level.png/image_view_fullscreen">http://ossfoundation.us/projects/environment/global-warming/myths/images/sea-level/Post-Glacial_Sea_Level.png/image_view_fullscreen</a></p>
<p>2</p>	<p>Sea level, m</p> <p>Global Mean T, °C</p> <p>Eocene 40 Myr ago</p> <p>Eemian 120 kyr ago</p> <p>Today</p> <p>Pliocene 3 Myr ago</p> <p>Forecast Year 2100</p> <p>Last Glacial Maximum 20 kyr ago</p> <p>(Figure 3 in “The millennial atmospheric lifetime of anthropogenic CO<sub>2</sub>” by David Archer &amp; Victor Brovkin - Climatic Change (2008) 90:283–297;</p> <p>There is a clear and strong correlation between long-term global average temperature and sea level in the geologic record. Sea level has the potential to change much more than is forecast for the coming century, and it has done so in the past. The slope of covariation from the geologic record has been 10–20 m/°C. (Horizontal axis is atmospheric temperature in degrees C)</p> <p><a href="https://geosci.uchicago.edu/~archer/reprints/archer.2008.tail_implications.pdf">https://geosci.uchicago.edu/~archer/reprints/archer.2008.tail_implications.pdf</a></p>
<p>3</p>	<p>The Earth was ice-free at the start of Oligocene (34 million years ago), when the temperature was 4-6° C warmer and the oceans were about 70 meters higher</p>

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Because there is a lot of ice in Antarctica at high elevations, sea levels are apt to rise more slowly as the temperature increases (and a lot of ice will not likely melt until the increase is over 4° C). The graph below shows that the expected equilibrium sea level rise is about 20 meters for the CO2 that is currently in our atmosphere



Cross-plot of estimates of atmospheric CO2 and coinciding sea level

<http://www.pnas.org/content/110/4/1209.figures-only>

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IPCC AR5 [https://www.ipcc.ch/pdf/unfccc/cop19/3\\_gregory13sbsta.pdf](https://www.ipcc.ch/pdf/unfccc/cop19/3_gregory13sbsta.pdf)

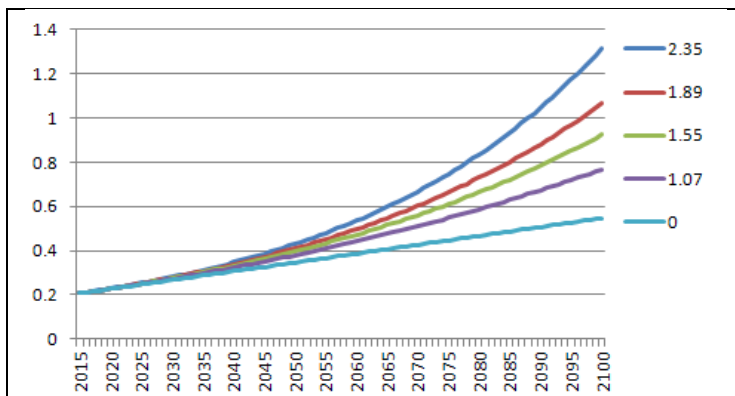
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<http://ocean.nationalgeographic.com/ocean/critical-issues-sea-level-rise/>

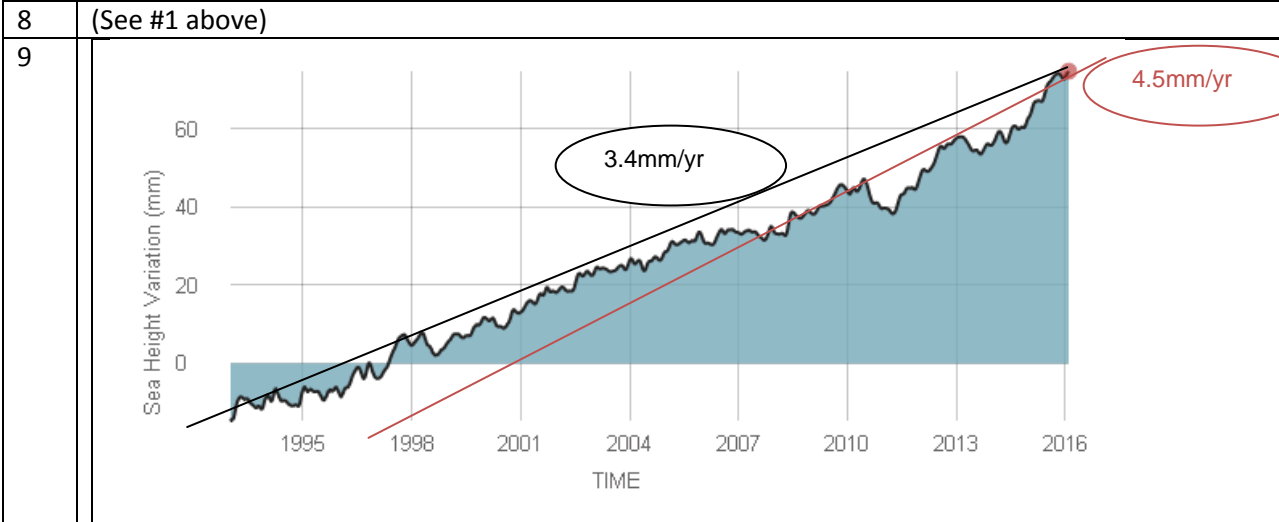
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**Expected Sea Level Rise for different rates of annual growth after 2015**

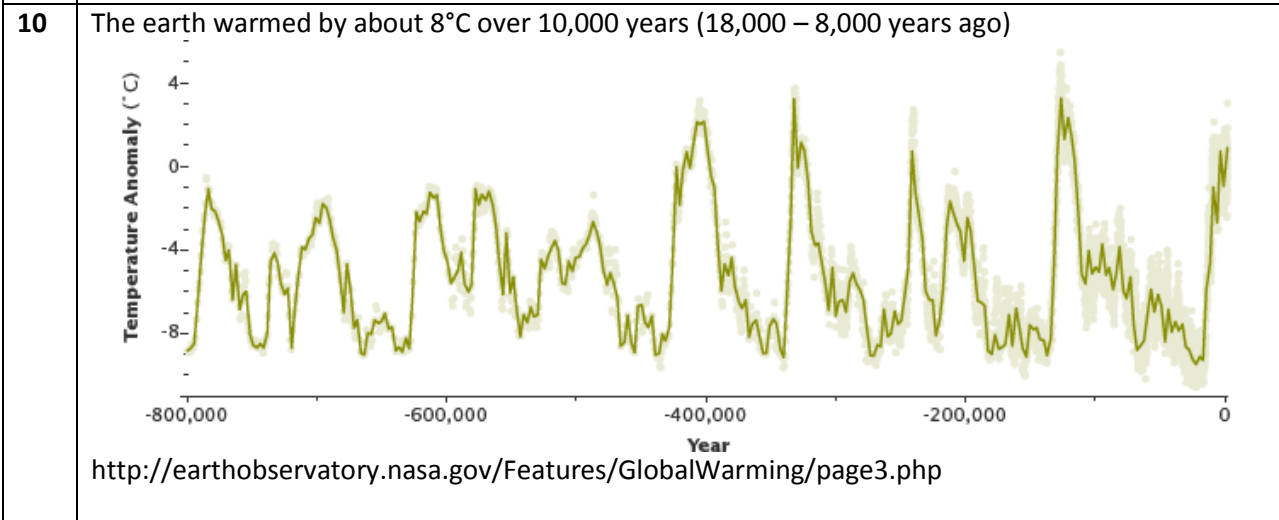
Recent sea level rise has been fairly linear, but with increasing temperatures the rate of increase will likely rise



Total sea level rise (in meters) from pre-industrial times, assuming a 4mm annual increase in 2015 and the specified per cent increase per year through 2100. (For a 1.07 percent increase, the global SLR would be 1.24 feet in 2050 and 1.56 feet in 2065; for a 2.35 percent increase, the global SLR would be 1.41 feet in 2050 and 1.96 feet in 2065)



Recent Sea Level Rise (<http://climate.nasa.gov/vital-signs/sea-level/>)



Data source: [http://data.giss.nasa.gov/gistemp/graphs\\_v3/fig.A2.txt](http://data.giss.nasa.gov/gistemp/graphs_v3/fig.A2.txt)