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# Sea level and CO2. Lessons from the past

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Background: Larger climate changes have in earth geophysical history typically been realised through thousands of years. Sometimes, however, also more rapid changes within decades have been observed. In order to predict how the global sea level will be influenced by different increments in CO2, it is important to discriminate between the final equilibrium state at a certain CO2 content, and the period required to accomplish the new equilibrium state. While equilibrium states of sea level under different CO2 conditions can be roughly extrapolated from the past, and therefore are relatively certain, many difficulties attach to the prediction of how long time it will take before a new equilibrium state is achieved. Aim: To assess the equilibrium state of sea level on earth last time the CO2 content of the atmosphere was of the present magnitude; 385 parts per million (ppm), and to assess the sea level and CO2 last time the earth was without permanent ice sheets. Methods: Last time the CO2 atmospheric content was 385 ppm is during the Pliocene epoch 3½- 4 million years ago, and last time we had an ice-free world is about 40 million years ago during the Paleogene period. We have examined studies assessing temperature and sea levels at these two moments in earth history. Results: The decrease in atmospheric CO2 40 million years ago was the main reason for in first instance the Antarctic and later the northern polar glaciation. At that time the global sea level was 80 m above the present level and the global average temperature approximately 6 degrees above the present. During the following millions of years the CO2 gradually decreased further, until it about 4 million years ago reached the 385 ppm level. The temperature at that time was approximately 3.5 degrees above the temperature of today, and the global sea level 20-30 above present level. Interpretation: The earth history demonstrates that even small changes in temperature or CO2 may bring about rather dramatic changes in sea level. The most likely sea level if the present CO2 continues would be 20-30 m above present level. Taking into account that rapid changes in the physical conditions on earth previously have brought about fast changes in temperature and sea level, a total of half of a meter increase in sea level within this century - which is the IPCC projections - is probably a severe underestimation of the most likely scenario within this century. A continued increase in CO2 emission to about 480 ppm may result in an ice free world as we had last time 40 million years ago. With the six degrees higher temperature, and sea levels 80 m above present levels, this scenario would severely challenge human civilisation. Conclusion: A global political commitment to prevent further increments in atmospheric CO2 probably demands realistic projections of climate scenarios without such a rapid and determined global intervention. Such projections have not - so far - been sufficiently clear and unequivocal to bring about demands of rapid and drastic political actions from people around the world.

 