Our Ocean Backyard — *Santa Cruz Sentinel* columns by Gary Griggs, Director, Institute of Marine Sciences, UC Santa Cruz.

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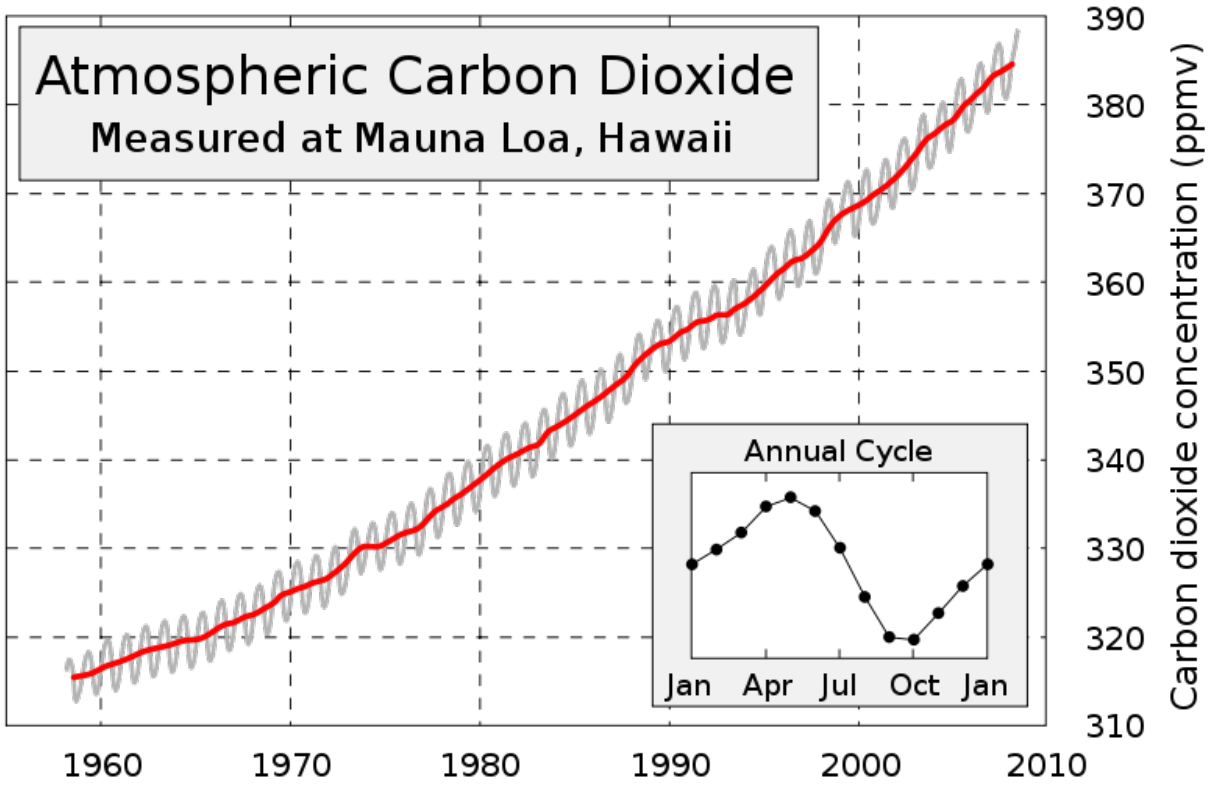
Messing with the atmosphere



The carbon dioxide content of the atmosphere measured in Hawaii, far from any industrial sources has increased over the past 50 years from 315 parts/million to 385 ppm or an increase of 22%.

One thing that scientists agree on today is that global climate has constantly changed throughout Earth history, and that key drivers are the oscillations in the Earth's rotation on its axis and in its orbit around the sun. These cycles are well understood and predictable. They take place over tens of thousands of years and are way beyond human control. They just are.

There is also no scientific disagreement that sea level has risen and fallen repeatedly throughout geologic time in response to climate change. Sea level just happens to be at a high point right now simply because we are in a relatively warm

climate phase and much of the Earth's ice has melted. But sea level has been considerably lower in the past and it has also been somewhat higher.

The question that often generates the most discussion is how much human activity is affecting climate change, which directly affects sea level. When it gets warmer, glaciers and ice caps melt and sea level rises. There's a very direct connection.

A half-century ago several scientists at the Scripps Institution of Oceanography had the suspicion that our burning of increasing amounts of fossil fuels, primarily coal, oil and gas, could be affecting the carbon dioxide content of the atmosphere. One of those scientists, Charles Keeling, went to the Mauna Loa Observatory in Hawaii where he felt the air would be uncontaminated by industry, and began to measure the amount of carbon dioxide. While most of our air consists of nitrogen and oxygen, he found when he arrived in Hawaii in 1958 that the carbon dioxide concentration was 315 parts per million (ppm). Year after year Keeling continued these annual measurements, and each year the concentration of carbon dioxide increased.

Charles Keeling died in 2006, but by this time the carbon dioxide concentration had increased 20% to 380 ppm. His son, Ralph Keeling, a climate scientist at Scripps took over the measurements. Carbon dioxide is now at 387 ppm. Many scientists credit Keeling's careful measurements with first bringing the world's attention to the effects that human activity were having on the Earth's atmosphere and climate.

But is 50 years really long enough to get a representative record? In order to get a longer-term picture of the significance of these changes, scientists have now taken measurements of the carbon dioxide concentration in ancient air bubbles trapped in polar ice cores. These analyses show that average atmospheric CO_2 concentration has been between 275 and 280 ppm throughout the past 9000 years, but started rising sharply at the beginning of the nineteenth century.

The CO_2 content of the atmosphere has increased about 38% over the pre-industrial levels and is now well beyond the range ever experienced in the entire time that humans have existed on the Earth. The increase is considered to be largely due to the combustion of fossil fuels. Since carbon dioxide is a greenhouse gas, this has significant implications for global warming. There is a natural greenhouse effect, which makes the Earth a pleasant place to live, but we have now added an additional greenhouse effect, and therein lies a problem.