# Climate change more than just a myth

**by Dr. Jim Reynolds**
Faculty Contributor

The climate is changing; few Earth scientists deny that. The Arctic Ocean is melting. There is only one way to melt ice at 1 atmosphere of pressure.

An ice free Arctic Ocean will create drastic changes in the ocean and atmospheric circulation patterns that govern climate. Seven years ago I first expressed my opinion that these changes will fairly rapidly bring a return to Ice Age conditions.

Gas bubbles trapped in the ice of the great ice caps of Antarctica, Greenland, Iceland, Patagonia, and Baffin Island provide continuous records of atmospheric compositions going back hundreds of thousands of years and can usually be dated to within a few tens of years.

The annual ice layer stratigraphy is calibrated by dated volcanic ash deposits from gigantic eruptions and other techniques. Carbon dioxide concentrations remained fairly constant for hundreds of thousands of years.

Only when burning coal began in earnest, at the dawn of the Industrial Revolution, did $CO_2$ concentration begin to rise. It has continued to rise ever since.

Accompanying the rise, exponential growth of the human population translated to higher demand for carbon-based energy.

We emit 26 billion tons of carbon dioxide into the atmosphere each year. Carbon dioxide absorbs heat and retains it in the atmosphere a little longer than it used to do before radiating it back into space.

With this energy pileup taking place in the sky, a rise in temperature is the only recourse.

Prior to the Industrial Revolution, biomass was used as the major energy source. It was harvested from the environment and cycled back into the environment at a sustainable rate. Coal was only a minor energy source, used locally since antiquity.

Earlier in Earth history, carbon dioxide was more abundant in the atmosphere. Much of the carbon removed from the early atmosphere eventually ended up in plants through photosynthesis.

Forests first appeared about 400 million years ago. Coal forms from plant leaves and twigs submerged in swamps. These decompose but once all of the oxygen in the water is used up the decay ceases; organic litter accumulates, sequestering the carbon for long periods of time. Earth experienced two major eras of coal formation: 1) the Pennsylvanian Period (325-286 million years ago) and the upper Cretaceous Period (~100-65 million years ago).

Both times coincided with very high sea levels that flooded the continental lowlands. Numerous river delta swamps developed in the shallow seas. A seaway stretched from the Gulf of Mexico to the Arctic Ocean in the Cretaceous.

Climate change deniers frequently claim that Earth's atmosphere is too big for us to have any long-term effect on it.

One of my favorite tales from Geology is about the evolution of the modern atmosphere. Much simpler organisms slowly changed its chemistry over a long period of time.

Earth became a planet about 4,500,000,000 years ago when it ceased being a molten protoplanet and formed a thin crust. Plate tectonics probably started the same day.

The planet was under constant bombardment from asteroids, meteors, and comets. Comets are composed primarily of ice and are credited with delivery of Earth's water supply from the cometary storeroom in the outer reaches of the Solar System.

Low areas filled with water; water vapor billowed into the air as it cooled the hot rocks below. Gases released from volcanoes, tectonic fissures, and areas where impacts punctured the thin crust added nitrogen, carbon dioxide, carbon monoxide, ammonia, nitrogen dioxide, sulfur dioxide, hydrogen sulfide, and hydrochloric acid: all in all a ghastly lethal mixture.

When it rained, the dissolved gases created a primordial caustic acid soup for an ocean.

Acids dissolved trillions of tons of iron minerals into the ocean during the first billion years of Earth history.

The water had a distinct dark, murky color. Today's ocean has no dissolved iron. What happened?

Somehow life evolved in that poisonous porridge of an ocean. Since there was no oxygen, different primitive bacteria evolved to extract energy from the chemicals present in their environment.

Some learned to live off of sulfur dioxide, others from hydrogen sulfide. Cyanobacteria used sunlight to convert carbon dioxide and water into a sugar, producing a waste gas of oxygen ($O_2$). Photosynthesis was born.

As soon as that first bubble of oxygen hit the water, it oxidized some dissolved iron ions to form an iron oxide mineral: hematite ($Fe_2O_3$) or magnetite ($Fe_3O_4$).

Neither of these minerals dissolves readily in acid water so the mineral grains plunked down on the ocean floor. This started a rain of oceanic iron that continued for the next billion years.

Virtually all of the of the great iron deposits society uses formed during this period. In the U.S., these rocks, called Banded Iron Formation, are found in northern Minnesota.

The iron rain ended about two and a half billion years ago. Seawater finally started to absorb the oxygen, gradually neutralizing the acids.

Since oxygen was toxic to most life forms, they died off, making more room for the photosynthisizers. Oxygen-tolerant organisms evolved and continue to dominate the planet.

Eventually, oxygen leaked into the atmosphere but before it could build up, it had to oxidize all of the iron minerals that had weathered out of the rocks on the barren continents.

The continents rusted red before oxygen finally began to accumulate in the atmosphere. It's been accumulating ever since, now comprising 21% of the atmosphere.

Coal and hydrocarbons are fossil sunlight, sequestered ancient energy and carbon from the ancient environment. On Earth, we add 71 million tons of carbon

see Atmosphere, p. 6