

# Global warming — It's a gas...

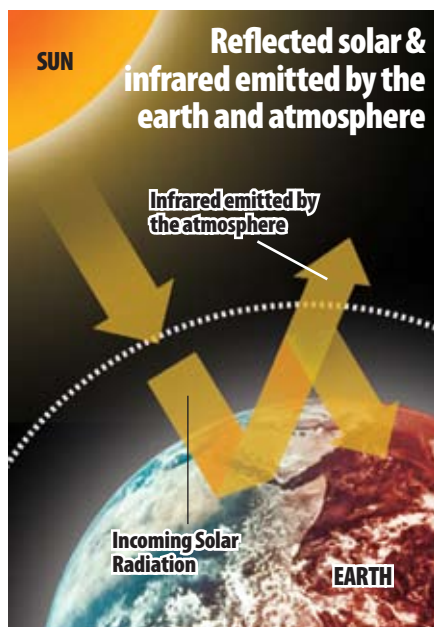
The greenhouse effect is what happens when certain atmospheric gases trap energy that otherwise would be lost to space. This effect is natural and supports life, but human activities have caused some of these gases to increase artificially, leading perhaps to climate change. In February 2007, the Intergovernmental Panel on Climate Change — top scientists from many countries — declared that human activities since the industrial revolution have likely caused global warming. That group wasn't the first to weigh in on mankind's effect on climate.

Scientists began to theorize about global warming as far back as the 19th century with Jean Baptiste Joseph Fourier, a French mathematician and physicist, who postulated in an 1827 essay that atmospheric gases might affect the planet's temperature. Svante Arrhenius, a Swedish chemist, made reasonably accurate calculations about global warming in 1896. He developed a theory that varying levels of carbon dioxide in the atmosphere

could raise the temperature of the surface of the Earth and account for prehistoric ice ages. To understand global warming, we need to start at the source: the sun.

Sunlight is the primary heat source for our planet. The sun heats the Earth, the Earth transfers that heat to the atmosphere. The surface of the sun emits radiation at a temperature of around 10,000 degrees Fahrenheit. Lucky for us the sun is far enough from the Earth that our surface temperature is somewhere around a balmy 53 degrees F at ground level. But it's not just the distance that keeps our planet at such a human-friendly temperature. The Earth's surface is warmer than 0 degrees F because it is heated by both sunlight and infrared light emitted by the atmosphere.

Gases that emit and absorb infrared light



are perhaps more properly called “infrared active gases” because their molecules vibrate and rotate when they are stimulated by infrared light, producing heat. Contrary to popular belief, the primary greenhouse gas is not carbon dioxide, but ordinary water vapor. Water vapor is the most important infrared active gas in our atmosphere because it absorbs and emits infrared light at most wavelengths. Clouds are also very active infrared absorbers and emitters, and they also scatter a lot of sunlight back to space that would otherwise heat the surface. In order, the major greenhouse gasses are water vapor, carbon dioxide, methane, and ozone. But carbon dioxide is the gas that we humans not only have the most power to control, but which also is largely responsible for the recent warming trend. We also have some control over methane and ozone gases.

Ozone, it should be noted, is a reactive gas formed when three oxygen atoms bond together. Ozone in the stratosphere is a good thing because it absorbs UV light that would otherwise kill plants and animals on Earth.

The issue with ozone depletion is that chlorofluorocarbons destroy stratospheric ozone, so their use in propellants in spray cans and in refrigerators has been phased out in many places. Both ozone and chlorofluorocarbons contribute to global warming, albeit with less gusto than other molecules like water vapor and carbon dioxide.

Gasoline- and diesel-powered vehicles, coal-fired power plants and animals use organic molecules as fuel and give off, among other things, carbon dioxide and water vapor. Plants, rocks and oceans are depositories for some of the carbon dioxide. The National Oceanic and Atmospheric Administration has been making carbon dioxide measurements at Mauna Loa in Hawaii since 1959. Carbon dioxide levels from before that time are inferred from measurements of air bubbles trapped in ice cores.

Currently, out of 1 million air molecules, 380 are carbon dioxide. Fifteen years ago when I first started teaching at Nevada, the number was around 365, and in the year 1750, prior to the industrial revolution, the number was closer to 280. This number keeps going up because we keep burning coal, oil, wood and cow dung, and because nature also dishes out carbon dioxide from volcanoes. The global warming fuss is really about a few potent molecules.

Suppose we instantly doubled the number of carbon dioxide molecules in the atmosphere? Not much would happen to the amount of sunlight initially absorbed at the Earth's surface, but the atmosphere would now absorb and emit more infrared light, which in turn would heat up the land and oceans. This is why we are concerned about the levels of infrared active gases like carbon dioxide in the atmosphere. Earth's land and ocean surfaces effectively absorb infrared radiation, but they respond by evaporating more water vapor. Land surfaces heat in a fairly predictable manner, but when oceans are heated they respond by circulating the

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## Ten Things You Didn't Know About . . .

# Nevada weather

By Jeff Underwood


water around as they try to make the temperature the same everywhere. As the oceans warm, glaciers, such as the one that covers Greenland, have begun to melt, which in turn causes sea levels to rise.

Earth's climate has been through some interesting gyrations over the past several hundred million years. Inferences are that 300 million years ago, oxygen was 35 percent of the atmosphere instead of 20 percent as it is now. It may have been that at one time, with all the continents huddling near the equator, deposition of atmospheric carbon dioxide into rocks and oceans was very effective to the point that a vast ice age ensued. The cycle changed with volcanic eruptions

### LOOK ONLINE

More information, visit <http://www.physics.unr.edu/ATMS.html>

of infrared active gases. The development of agriculture in the last 8,000 years may

have produced enough methane and carbon dioxide to prevent us from sliding back into an ice age. But changes in the level of carbon dioxide and methane over the last 700,000 years are linked in lockstep with atmospheric temperature changes. May hindsight help us with foresight. 

### READING LIST

1. *Clouds in a glass of beer: Simple experiments in atmospheric physics* by Craig Bohren.
2. *What light through yonder window breaks?* By Craig Bohren.
3. *Kicking the Carbon Habit* by William Sweet.

### MOVIES

1. *An Inconvenient Truth* by Al Gore.
2. *The Great Global Warming Swindle* by TotalDrive!, available from <http://www.youtube.com/watch?v=XttV2C688pU>.

### WEB SITES

A look at the amount of sunlight and infrared light around the world at the website <http://cmdl1.cmdl.noaa.gov:8000/www/all/rad/>  
BBC News: Guide to Climate Change: [http://news.bbc.co.uk/2/shared/spl/hi/sci\\_nat/04/climate\\_change/html/greenhouse.stm](http://news.bbc.co.uk/2/shared/spl/hi/sci_nat/04/climate_change/html/greenhouse.stm)

1. There are locations in Nevada where two points separated by very little distance receive vastly different amounts of precipitation. For example Mt. Rose and Reno in northern Nevada are separated by less than 20 miles. Mt. Rose however receives more than 25 inches of precipitation (rainfall equivalent) per year compared to Reno at less than seven inches.
2. Nevada is a great place to observe dust devils — tightly swirling winds created by extreme surface heating. During the summer months across Nevada, soil temperatures can rise well above 120 degrees Fahrenheit while the air above the soil is cooler (90-100F). This difference in temperature can spawn a dust devil that can produce wind speeds of more than 60 mph.
3. Many places in Nevada experience daily temperature ranges that are nearly unbelievable to observers in other regions of the country. For example, a normal July day in Washington, D.C., features a high temperature at 89F with a low of 71F, a daily range of 18F. Compare this to Elko, where a normal July day will see a high temperature of 91F and a low of 48F, a range of 43F.
4. Northern Nevada is the best location in North America to observe stationary lenticularis clouds (inset). These lens-shaped clouds form on the downwind side of the Sierra Nevada. Often lenticular clouds form in rows with a single, large lens-shaped cloud followed by many smaller stationary clouds. Since this formation of gleaming, saucer-like clouds lingers in the same location for long periods, many UFO and flying saucer reports have in fact turned out to be stationary lenticularis clouds.
5. Nevada is the driest state in the nation. When averaging precipitation totals from all of the reporting stations across the state, Nevada's statewide average is around seven inches per year.
6. According to the U.S. Historical Climatology Network, Nevada has the fewest weather observation stations of any state. Nevada does, however, have three National Weather Service forecast offices (Reno, Elko and Las Vegas) and is one of 36 states to have an Association of American State Climatologist-recognized state climate office.
7. Although it is the driest state in the country, many parts of Nevada are prone to flooding. The Truckee, Carson and Humboldt rivers flood during heavy winter season rainfall or rain-on-snow episodes. Washes, roadways and streets in the southern portion of the state are at risk for flash flooding during summer thunderstorms.
8. During the heatwave of 2005, on July 19, the city of Las Vegas set two temperature records. The first was a new record high temperature of 117F. The second was a record for the highest nighttime low temperature, 96F. It was so hot that afternoon many aircraft at McCarran International Airport could not depart because the extremely hot air was not dense enough to allow for liftoff.
9. During a period from March 1928 through January 1929, the town of Mina went 312 consecutive days without recording a drop of rainfall.
10. Drought and wildfire are the most costly weather-related hazards facing the state. In 1994 wildfire and drought cost the state in excess of \$1 billion.

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