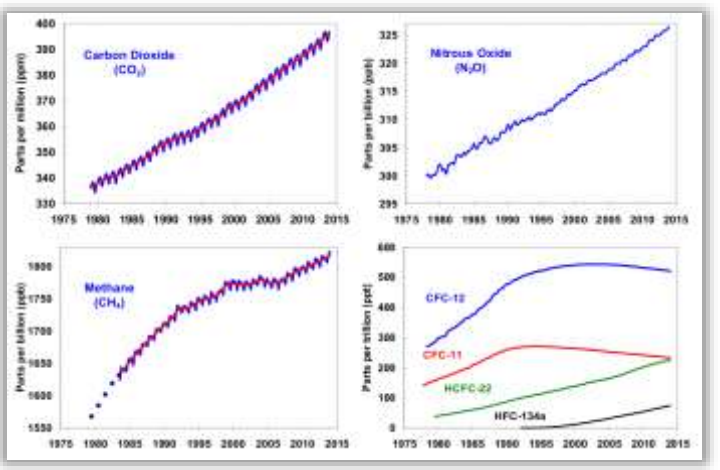
TEACHER BACKGROUND:
ATMOSPHERIC TRACE GASES and GLOBAL WARMING

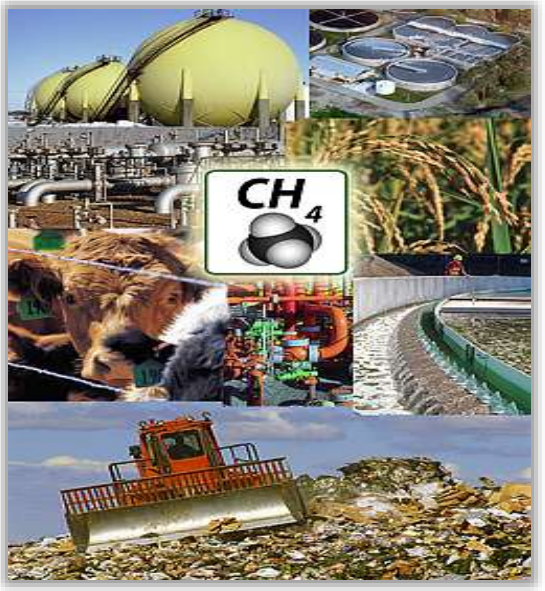


Most of our atmosphere is made up of nitrogen (78%) and oxygen (21%). The remaining 1% of the gases are known as ***trace gases*** and are present in very small concentrations. The most important of the trace gases involved in climate change are ***carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and chlorofluorocarbons (CFCs).***

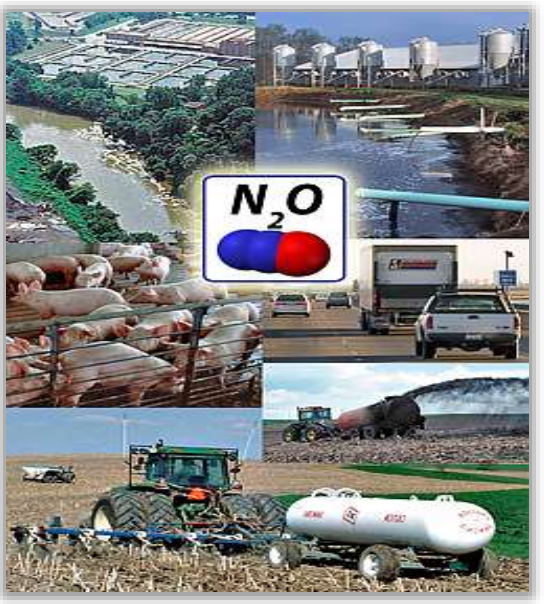
The first three gases are naturally occurring greenhouse gases and are what make Earth habitable for life as we know it. According to the **Intergovernmental Panel on Climate Change** (IPCC), atmospheric concentrations of greenhouse gases—primarily carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)—have drastically increased as a result of human activities since 1750 (the Industrial Revolution), and now far exceed pre-industrial values determined by ice core data spanning the past 10,000 years.

Carbon dioxide (CO_2) is produced naturally through respiration, decay of plant/animal matter and forest fires. Man-made sources of CO_2 include fossil fuel combustion, land use changes (primarily deforestation), biomass burning and the manufacture of cement. The main removal processes(sinks) for carbon dioxide is absorption by the oceans and terrestrial biota, especially forestry. Carbon dioxide is the dominant greenhouse gas. In fact, the effectiveness of other compounds in contributing to global warming on a molecule-by-molecule basis is measured relative to CO_2. is referred to as the compound's ***Global Warming Potential (GWP)***. The Global Warming Potential is a measure of how much heat a greenhouse gas traps in the atmosphere as well as its lifetime in the atmosphere.

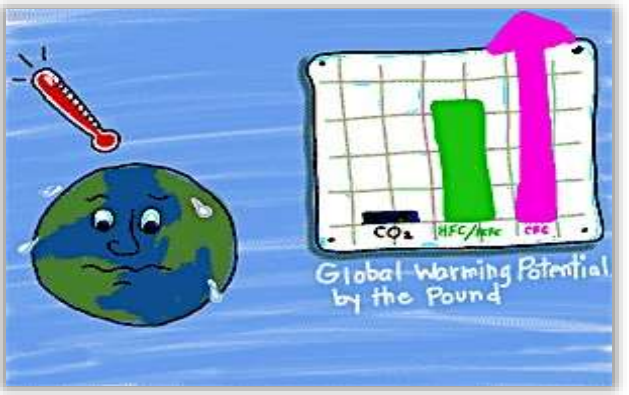
***Methane* (CH_4)** is at least 56 times more heat trapping than a molecule of CO_2. Natural sources include wetlands, geological sources, oceans and termites. The major sources resulting from human activity are the decomposition of waste, landfills, agriculture (from ruminant digestion, rice patties), fossil fuel extraction and use and biomass burning. Despite the fact that methane is a much stronger heat-trapping gas than carbon dioxide, it has a **GWP** of only 21 because it breaks down much faster in the atmosphere. While CO_2 remains in the atmosphere for at least a century, CH_4 lasts only about a dozen years.



***Nitrous oxide* (N_2O)** is the third strongest greenhouse gas after carbon dioxide and methane. It is a powerful greenhouse gas produced both naturally and via human activities. Its concentration in the Earth's atmosphere has risen by around 15% since the Industrial Revolution. The atmospheric concentration for nitrous oxide is around today is about 315 ppb compared to a pre-industrial high of 275 ppb. It is emitted in nature by bacteria in the soils and oceans. Although its concentration the atmosphere is much smaller than that of carbon dioxide, N_2O is a much more effective greenhouse gas having a **GWP** of 298 over a 100-year time span. The production of nitrogen fertilizers and nylon is an important source of global N_2O emissions, as well as fossil fuel burning for power. Other important human-made sources of N_2O include biomass burning, cattle and cattle feed production.



Chlorofluorocarbons, commonly known as ***CFCs*** or ***Freon,*** are a group of man-made compounds containing chlorine, fluorine and carbon. They are not found anywhere in nature. The production of CFCs began in the 1930s for the purpose of refrigeration. Since propellants in aerosols, as blowing agents in foam manufacture, in air conditioning and as a cleaner for electronic circuit boards. Much of the modern lifestyle of the second half of the 20th century was made possible by the use of CFCs.



There are no ***sinks*** for CFCs. Although the amounts of CFCs in the atmosphere are very small, measured in parts per trillion (million million), they do contribute significantly to the ***enhancement*** of the natural greenhouse effect, because they are very good at trapping heat. Molecule for molecule some CFCs are thousands of times stronger than carbon dioxide as greenhouse gases.

Since the dangers caused by CFCs to the ozone layer were first identified, their use has gradually been phased out, according to international agreements made in Montreal, Canada, in 1987. However, because CFCs have long lifetimes in the atmosphere before they are broken down by sunlight, they will continue to enhance the greenhouse effect well into the 21st century.

According to the World Meteorological Organization's Annual Greenhouse Gas Bulletin, the amount of greenhouse gases in the atmosphere reached a new record high in 2013, propelled by a surge in levels of carbon dioxide. These increases added even greater urgency into the need for intensive international action against accelerating and potentially devastating climate change.