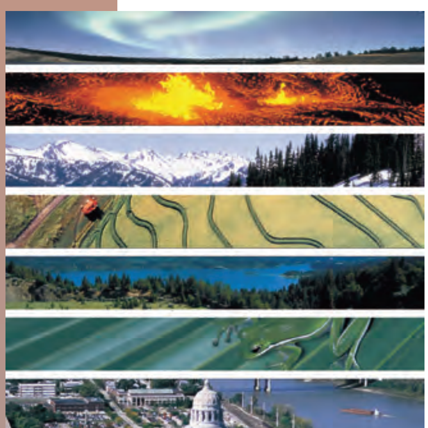
U.S. Climate Change Science Program

Methane as a Greenhouse Gas

Methane (CH_4) is the primary component of natural gas and an important energy source. Methane is also a greenhouse gas, meaning that its presence in the atmosphere affects the Earth's temperature and climate system. Due to its relatively short life time in the atmosphere (9-15 years) and its global warming potency—20 times more effective than carbon dioxide (CO_2) in trapping heat in the atmosphere—reducing methane emissions should be an effective means to reduce climate warming on a relatively short time scale.

Human-influenced sources of methane include landfills, natural gas and petroleum production and distribution systems, agricultural activities, coal mining, stationary and mobile combustion, wastewater treatment, and certain industrial processes. About 60% of global methane emissions come from these sources and the rest are from natural sources (IPCC, 2001). Natural sources include wetlands, termites, oceans, and hydrates (which consist of methane molecules each surrounded by a cage of water molecules and are present in seafloor deposits around the world).

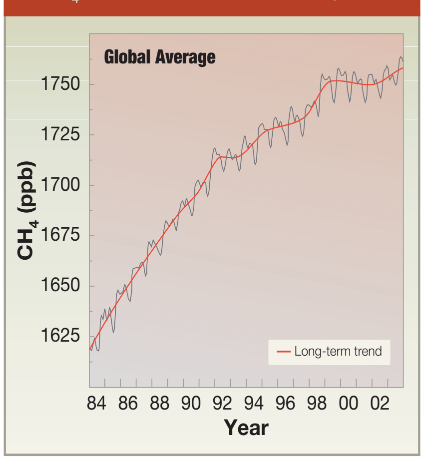
Methane is one of several non-CO_2 gases that contribute to global climate change. Human-influenced sources include landfills, natural gas and petroleum production and distribution systems, agriculture, coal mining, combustion, wastewater treatment, and certain industrial processes. Natural sources include wetlands, termites, oceans, and hydrates.



The historical record, based on analysis of air bubbles trapped in ice sheets, indicates that methane is more abundant in the Earth's atmosphere now than at any time during the past 400,000 years (IPCC, 2001). Over the last two centuries, methane concentrations in the atmosphere have more than doubled. However, in the past decade, while methane concentrations have continued to increase, the overall rate of methane growth has slowed (Dlugokencky *et al.*, 2003). Given our incomplete understanding of the global methane budget, it is not clear if this slow down is temporary or permanent.

Once emitted, methane is removed from the atmosphere by a variety of processes, frequently called "sinks." The balance between methane emissions and methane removal processes ultimately determines atmospheric methane concentrations, and how long methane emissions remain in the atmosphere. The dominant sink is oxidation by chemical reaction with hydroxyl radicals (OH).

CH_4 Concentration in the Atmosphere



Source: NOAA Climate Monitoring and Diagnostics Laboratory

Scientific Research on Methane

Scientific agencies within the Federal government are actively researching many aspects of methane, all of which have an impact on global climate change. Research utilizes observations, inventories, and computer models to help scientists determine how much methane is being put into the atmosphere, its effects on the global climate, and how the amount of methane in the atmosphere can be reduced.

Scientists take air measurements around the world in distant and remote places, as well as in populated areas to calculate averaged global concentrations. They also maintain running inventories of methane emission factors and activities. By

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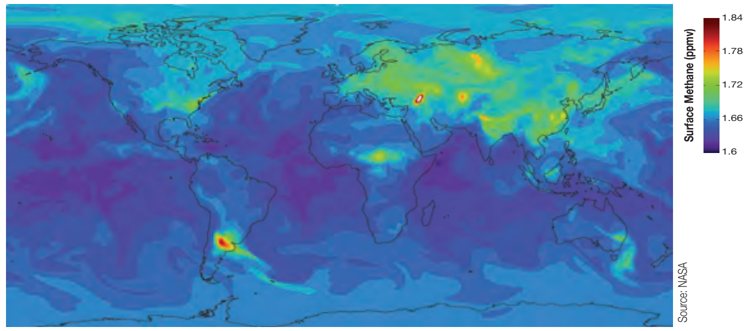

Distribution of methane at the Earth's surface as calculated by a NASA computer model.

doing this on an ongoing basis, they can track the changes in overall concentration from year to year and detect whether global methane concentrations are rising or falling. These trends are factored into calculations of how atmospheric composition has affected or "forced" our climate. These observations are also used to estimate how long methane persists in the atmosphere.

Regardless of the source of methane—whether human-produced or natural—data on why, how much, and where methane is being emitted are being used to complete the picture of assessing the role of methane in the Earth system.

Reducing Atmospheric Methane Concentrations: Methane to Markets

U.S. government programs to reduce atmospheric methane concentrations have led to emissions reductions of about 10% below 1990 levels (EPA, 2005). These voluntary programs have targeted methane reductions in coal mining, landfills, oil and natural gas systems, and agriculture by more effectively capturing methane during fossil-fuel extraction, capturing methane from landfills, and reducing biomass burning. A new partnership called *Methane to Markets* (<http://www.epa.gov/methanetomarkets>) led by the U.S. Environmental Protection Agency was initiated in 2004 to engage developed countries, developing countries, and countries with economies in transition, and the private sector, in an international effort to reduce methane emissions.

The Partnership will reduce global methane emissions by recovery and use to enhance economic growth, promote energy security, improve the environment, and reduce greenhouse gas emissions. Other benefits include improving mine safety, reducing waste, and improving local air quality. The Partnership has the potential to deliver by 2015 annual reductions in methane emissions of up to 50 million metric tons of carbon equivalent (MMTCE) or recovery of 500 billion cubic feet (Bcf) of natural gas. These measurable results, if achieved, could lead to stabilized or even declining levels of global atmospheric concentrations of methane. To give a sense of scale, this would be equivalent to:

- Removing 33 million cars from the roadways for 1 year, planting 55 million acres of trees, or eliminating emissions from fifty 500 megawatt coal-fired power plants
- Providing enough energy to heat approximately 7.2 million households for 1 year.

Over the last two centuries, methane concentrations in the atmosphere have more than doubled, although the rate of growth of methane in the atmosphere has slowed in the last decade. Scientists are measuring the amount of methane in the atmosphere, where it is coming from and where it goes, and modeling its behavior to try to understand the effects of increased levels of methane in the atmosphere.

What *You* Can Do

The largest source of human-produced methane in the United States results from the breakdown of garbage in landfills. You can help reduce methane emissions the most by reducing the amount of trash you contribute. Other U.S. sources of methane include direct production from ruminant animals and methane that is released as a byproduct of transporting fossil fuel and fossil-fuel combustion. Using energy more efficiently will also help reduce national methane emissions.

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This fact sheet was generated by the Climate Change Science Program Office in collaboration with an interagency working group composed of representatives of the 13 Federal agencies participating in the U.S. Climate Change Science Program. For further information, see <www.climatescience.gov>.