New research provides blueprint for molecular basis of global warming

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Some common chemical molecules, most of them used industrially, may be more worrisome from a global warming perspective than carbon dioxide, according to a new study by Timothy Lee, chief of the Space Science and Astrobiology Division at NASA Ames Research Center. The study was collaboration between Lee and Joseph Francisco, a Purdue chemistry and earth and atmospheric sciences professor. Credit: Photo courtesy of NASA Ames Research Center

A new study indicates that major chemicals most often cited as leading causes of climate change, such as carbon dioxide and methane, are outclassed in their warming potential by compounds receiving less attention.

Purdue University and NASA examined more than a dozen chemicals, most of which are generated by humans, and have developed a blueprint for the underlying molecular machinery of global warming. The results

appear in a special edition of the American Chemical Society's *Journal of Physical Chemistry A*, released Nov. 12.

The compounds, which contain fluorine atoms, are far more efficient at blocking radiation in the "atmospheric window," said Purdue Professor Joseph Francisco, who helped author the study. The atmospheric window is the frequency in the infrared region through which radiation from Earth is released into space, helping to cool the planet. When that radiation is trapped instead of being released, a "greenhouse effect" results, warming the globe. Most of the chemicals in question are used industrially, he said.

NASA scientist Timothy Lee, lead author of the study with Francisco and NASA postdoctoral fellow Partha Bera, characterized the fluorinated compounds as having the potential to quickly slam the atmospheric window shut, as opposed to gradually easing it shut like carbon dioxide.

In the results, chemicals such as chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur and nitrogen fluorides stood out in their warming potential because of their efficiency to trap radiation in the atmospheric window.

"It's actually rather stark," said Francisco, a Purdue chemistry and earth and atmospheric sciences professor, whose research focuses on the chemistry of molecules in the atmosphere.

An understanding of how the chemicals contribute to climate change on a molecular scale affords the opportunity to create benign alternatives and to test new chemicals for their global warming capability before they go to market, Francisco said.

"Now you have a rational design basis," he said.

The researchers looked at more than a dozen chemicals, often referred to as "greenhouse gases," listed as warming agents by the Intergovernmental Panel on Climate Change, the most prominent international scientific group monitoring global warming. The study employed both results from experimental observations and from computer modeling using supercomputers from Information Technology at Purdue (ITaP), Purdue's central information technology organization, and NASA. The goal was to determine which chemical and physical properties are most important in contributing to global warming.

"Believe it or not, nobody has ever delineated these properties," Lee said.

CFC use has waned with the discovery that the chemicals contribute to the destruction of Earth's ozone layer, which absorbs most of the dangerous ultraviolet radiation from the sun. But HFCs and PFCs are widely used in air conditioning and the manufacturing of electronics, appliances and carpets. Other uses range from application as a blood substitute in transfusions to tracking leaks in natural gas lines.

"Although current concentrations of some of these trace gases have been found to be substantially small compared to carbon dioxide, their concentration is on the rise," the study notes. "With the current rate of increase, they will be important contributors in the future, according to some models."

The fluorine atoms that characterize the chemicals are highly electro-negative and tend to pull electrons to themselves, Francisco said. This shift makes the molecules more efficient at absorbing radiation, which would normally bleed harmlessly into space. As a result, the fluorine-containing compounds are the most effective global warming agents, the study concludes.

The compounds also persist longer than carbon dioxide and other major global warming agents, said Lee, chief of the Space Science and Astrobiology Division at NASA Ames Research Center. The concern is that, even if emitted into the atmosphere in lower quantities, the chemicals might have a powerful cumulative effect over time. Some of these chemicals don't break down for thousands of years.

Source: Purdue University (news : web)