Recent News

Young Team of Taiwan Atmospheric Chemists Publish Ozone Research in Science

A very young research team of undergraduate and graduate students led by Dr. Jim Jr-Min Lin, a Research Fellow at the Institute of Atomic and Molecular Sciences, Academia Sinica, recently revealed that carbonyl oxides predominantly react with water vapor in the atmosphere. Carbonyl oxides (so-called Criegee intermediates, named after Rudolf Criegee, a German chemist) are formed in the atmosphere by the reactions of unsaturated hydrocarbons with ozone. Criegee intermediates (CIs) are very reactive species that react quickly with a few key atmospheric molecules like sulfur dioxide (SO_2) and nitrogen dioxide (NO_2). The study of reactions involving CIs is crucial to atmospheric research, for example, for understanding the formation of aerosols and acid rain. However, because of their short lifetimes, little is currently known about CIs. Dr. Lin's research result, which clarifies the atmospheric fate of the simplest Criegee intermediate, was published in one of the world's leading journals *Science*, and featured on the *Science Express* website on January 1, 2015.

Carbonyl oxides or Criegee intermediates (CIs) are important transient species formed in the reactions of unsaturated hydrocarbons with ozone. Although direct detection of CIs has recently been realized, the main atmospheric sink (reaction to remove them) of Criegee intermediates remains unclear. In 2012, an efficient method for preparation of CIs was published by scientists in Sandia National Laboratory, USA. After that, a number of research groups around the world have focused on investigating the physical and chemical properties of CIs. However, limited by their experimental methods, they can only detect CIs under low pressure (less than one tenth of atmospheric pressure), in conditions far from the real atmosphere.

Dr. Lin's team successfully overcame the pressure gap by using ultraviolet absorption spectroscopy to detect CH_2OO, the simplest Criegee intermediate. They investigated the lifetime of CH_2OO under various humidity levels under near atmospheric pressures. The result indicated that the reaction of CH_2OO with water vapor requires two water molecules in total, one acting like a catalyst. Under typical atmospheric conditions, the CH_2OO reaction with water vapor is very fast, much faster than other CH_2OO reactions with SO_2 and NO_2. In fact, it is the predominant reaction for CH_2OO in the atmosphere. In other words, the chance of CH_2OO reacting with SO_2 and NO_2 is low. This novel and definitive finding provides important information for atmospheric chemistry.

"Additionally, our team members are exceptionally young, so their research potential is unlimited," Dr. Lin enthused. The first and second authors of the article, Mr. Wen Chao, and Mr. Jun-Ting Hsieh are undergraduate students at National Taiwan University and Stanford University, respectively. They joined Dr. Lin's research group because they had attended a high school scientific camp held by Dr. Lin four years ago. The third author Mr. Chun-Hung Chang holds a Master's degree from the Department of Physics, National Tsing Hua University.

The article, entitled “Direct kinetic measurement of the reaction of the simplest Criegee intermediate with water vapor” can be found:
http://www.sciencemag.org/content/early/2014/12/30/science.1261549

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Previously, Dr. Lin and his colleagues including Dr. Yuan-Tseh Lee, President Emeritus, Academia Sinica, had made a photochemical measurement of chlorine peroxide (ClOOCl), which cleared a major international debate on exactly how humans are depleting the ozone layer. Science published the paper in May 2009.