S. Solomon: **Changes in atmospheric composition: implications for irreversible climate change and mitigation choices**

Humankind has greatly perturbed the Earth's atmosphere, ushering in a new era sometimes referred to as the "anthropocene". Changes in greenhouse gases and aerosols have altered the Earth's energy budget and are the primary drivers of global climate change, prompting scientists, the public, and policymakers worldwide to consider both the scientific evidence and our choices regarding mitigation options. This talk will focus on the range of gases and particles contributing to anthropogenic perturbations to the atmosphere, the evolution of scientific understanding of each constituent's influence on our climate, and insights regarding policy choices. Analogous insights gained by comparing the Montreal Protocol that governs chlorofluorocarbons and ozone depletion to the Kyoto Protocol on climate change will also be discussed.

Concentrations of the key greenhouse gases carbon dioxide, methane, and nitrous oxide have increased to concentrations not experienced on Earth in many thousands of years. The concentrations of a range of particles such as mineral dust, black carbon, sulfate, and organics have also increased markedly. The radiative forcing due to each of these constituents contributes to current global climate changes. Recent research has highlighted the key role played by the time scales and processes that govern climate system responses to these chemicals. In particular, it has been recognized that the induced global climate changes last considerably longer than the gases or aerosols themselves. Indeed, the climate changes due to the dominant forcing agent, anthropogenic carbon dioxide, should be thought of as being essentially irreversible on time scales of at least a thousand years. While methane is a much shorter lived gas, anthropogenic methane nonetheless has impacts on the climate system on time scales considerably longer than its own atmospheric lifetime. The processes that prolong climate change well beyond the lifetime of the source gases or aerosols include non-linear aspects of spectroscopy and biogeochemistry, as well as ocean heat transfer, and will be compared and contrasted for different forcing agents in this talk. Consequences for climate change will be reviewed.

The largely irreversible nature of the climate changes due to carbon dioxide on human time scales has implications for understanding of how cumulative carbon dioxide emissions can represent a new metric of particular utility for policy. The use of cumulative carbon to better understand future climate changes will be described. Recent research has greatly improved the understanding of key metrics such as the global warming potential (GWP), global temperature potential (GTP), cumulative carbon, time horizons of policy metrics, and the interrelationships between these. Implications of choices among metrics for mitigation options and the consequences for our climate will be described.

Susan Solomon, Professor, University of Colorado, Boulder, United States

Dr Susan Solomon is widely recognized as one of the leaders in the field of atmospheric science. She was a scientist at NOAA in Boulder, Colorado, from 1981 to 2011 and has been an adjunct professor at the University of Colorado since 1982. She is well known for having pioneered the theory explaining why the ozone hole occurs in Antarctica and for obtaining some of the first chemical measurements that helped to establish chlorofluorocarbons as its cause. She is also the author of several influential scientific papers in climate science, including one on the irreversibilities of the climate change problem, and a popular book on Antarctic history, *The Coldest March* (selected as one of the books of the year for 2001 by *The New York Times*, the *Economist* (UK), and *The Independent* (UK)]. She received the 1999 National Medal of Science (the highest scientific honour in the US), as well as the Grande Medaille (the highest award of the French Academy of Sciences), the prestigious Blue Planet Prize in Japan, as well as the Volvo Environment Prize. She is a member of the National Academy of Sciences of the United States, the French Academy of Sciences, the Royal Society and the Acadameia Europaea. Solomon Glacier, in Antarctica, was named after her. She served as co-chair of the climate science group of the Intergovernmental Panel on Climate Change from 2002-2007. Time magazine named Solomon as one of the 100 most influential people in the world in 2008.