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Volcanic Perturbation of Stratospheric Ozone in Future Atmospheres

The physicochemical state of the stratosphere is evolving rapidly. Due to the success of the Montreal Protocol and its subsequent amendments, quantities of Equivalent Effective Stratospheric Chlorine (EESC) are declining and are expected to reach pre-ozone hole levels by the year 2070. Simultaneously, increases in greenhouse gases such as CO_2, CH_4, and N_2O are expected to alter halogen-mediated ozone processing through changes in the temperature structure of the stratosphere and changes to the stratospheric partitioning of inorganic chlorine. As a result, background processing of ozone by halogen species in the volcanically quiescent stratosphere will not be the same in the future as observed today.

In this seminar, I will explore how a future Pinatubo-like explosive volcanic eruption might interact with the stratospheric ozone layer within the envelope of climate futures informed by the Representative Concentration Pathways (RCPs). Additionally, it is now apparent that, under certain circumstances, large quantities of volcanic halogen species efficiently partition to the stratosphere, as confirmed by ice core analyses, in situ platforms, and remote sensing techniques. The ozone implications of halogen-rich explosive volcanism and possible mechanisms by which this stratospheric injection efficiency may be tuned will be discussed with particular emphasis on differential oxidative partitioning of Cl, Br, and I. Furthermore, the alpha factor, a measure of the ozone-destroying efficiency of a bromine (iodine) atom relative to a chlorine atom, is estimated to have a global-temporal average value of ~65 (250) in the present-day stratosphere. Although the state of the stratosphere is changing, benchmark projections of EESC treat these numbers as temporally invariant. I will present the alpha factors as a function of greenhouse gas emission scenario and time, finding significant variance in the temporal evolution of alpha between possible climate futures.