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Heterogeneous reactions of TiO_2 aerosol particles with N2O5 and $ClONO_2$ and their implications for stratospheric particle injection

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Injection of aerosol particles (or their precursors) into the stratosphere to scatter solar radiation back into space has been suggested as a solar radiation management scheme for climate engineering. Several minerals, including TiO_2, have been as possible candidate particles (instead of sulfuric acid) to be injected into the stratosphere, due to their high refractive indices. However, their heterogeneous reactivity towards important reactive trace gases in the stratosphere has seldom been investigated, impeding us from a reliable assessment of their impact on stratospheric O_3.

In this work, the heterogeneous reactions of airborne TiO_2 particles with N2O5 and $ClONO_2$ have been studied at room temperature and at different RH, using an atmospheric pressure aerosol flow tube. The uptake coefficient of N2O5, γ(N2O5), increased from $\sim$1.8E-3 at 5% RH to 4.5E-3 at $\sim$60% RH for TiO_2, significantly smaller than that for sulfuric acid particles in the stratosphere. The uptake of $ClONO_2$ onto TiO_2 aerosols particles have been found to be quite inefficient, with $\gamma(ClONO_2)$ not larger than 1E-3. Therefore, compared to stratospheric sulfuric acid particles, TiO_2 particles show similar reactivity towards $ClONO_2$ and much less reactivity towards N2O5.

The UKCA chemistry-climate model has been used to assess the impact of TiO_2 particles on stratospheric chemistry. A few scenarios have been constructed for TiO_2 particle injection to have the same radiative effect as the eruption of Mt. Pinatubo. We find that the impact of TiO_2 injection on stratospheric N2O5 is much smaller than the eruption of Mt. Pinatubo. The heterogeneous reaction of $ClONO_2$ with TiO_2 particles is being included in the model, and a comprehensive assessment of the effect of TiO_2 injection on stratospheric chemistry will be presented.