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Heterogeneous reaction of N2O5 with airborne TiO_2 particles and the implication 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 (SRM) scheme for the mitigation for global warming. TiO_2 has recently been highlighted as a possible candidate aerosol because of its high light scattering ability with a refractive index of 2.5 (Pope et al. 2012). The impact of particles injection on stratospheric ozone requires systematical assessment via laboratory and modelling studies.
In this work, the heterogeneous reaction of airborne sub-micrometre TiO_2 particles with N2O5 has been investigated at room temperature and different relative humidities (RH), using an atmospheric pressure aerosol flow tube. The uptake coefficient of N2O5 onto TiO_2, γ(N2O5), was determined to be $\sim$1.0$\times$10-3 at low RH, and increase to $\sim$3$\times$10-3 at 60% RH. The dependence of γ(N2O5) on RH can be explained by the water adsorption isotherm of TiO_2 particles.
In addition, the uptake of N2O5 onto TiO_2 aerosol particles has been included in the UKCA chemistry-climate model to assess the effect of N2O5 uptake onto TiO_2 particles on the stratospheric composition. We construct a case study based on the eruption of Mt. Pinatubo, comparing the effects of TiO_2 to those from the volcanic sulfate and to the situation with only background amount of aerosol. The changes in reactive nitrogen species and ozone due to the heterogeneous reaction of TiO_2 with N2O5 are assessed relative to sulfate aerosol impacts.

Pope, F. D., Braesicke, P., Grainger, R. G., Kalberer, M., Watson, I. M., Davidson, P. J., and Cox, R. A.: Stratospheric aerosol particles and solar-radiation management, Nature Clim. Change, 2, 713-719, 2012