2.092 Impact of C1-C5 alkyl nitrate chemistry on tropospheric ozone: box and global model perspectives.

Early Career Scientist

Presenting Author:
Maria Zamyatina, Centre for Ocean and Atmospheric Sciences, School of Environmental Sciences, University of East Anglia, UK, m.zamyatina@uea.ac.uk

Co-Authors:
Claire E. Reeves, Centre for Ocean and Atmospheric Sciences, School of Environmental Sciences, University of East Anglia, UK
Alex T. Archibald, Department of Chemistry, University of Cambridge, UK
Paul T. Griffiths, Department of Chemistry, University of Cambridge, UK
Marcus O. Köhler, Centre for Ocean and Atmospheric Sciences, School of Environmental Sciences, University of East Anglia, UK

Abstract:

Alkyl nitrates (RONO$_2$) are organic trace gases that are emitted from oceanic and biomass burning sources and produced photochemically from the oxidation of hydrocarbons (RH) in the presence of nitrogen oxides (NO$_x$). Their formation terminates the catalytic tropospheric ozone production by temporarily storing the active form of nitrogen. Due to a relatively long lifetime of a few days to a few months they can be destroyed far away from their sources by photolysis or OH radical oxidation, releasing NO$_2$ back to the local atmosphere. Given the right circumstances, this might change ozone concentrations on regional levels and alter the oxidative capacity of the atmosphere. The RONO$_2$ chemistry is currently under-represented in global chemistry-climate models. If present, they appear in a lumped form or only short-chained nitrates are considered explicitly. Here we extend the tropospheric chemical mechanism (CheT) of the UK Chemistry and Aerosols (UKCA) model to include the chemistry of C$_2$-C$_5$ RONO$_2$ and C$_4$-C$_5$ alkanes. The new mechanism is tested in a box model in a range of NO$_x$ and RH conditions using the Master Chemical Mechanism (MCM) as a benchmark. Two types of box modelling experiments show that the inclusion of RONO$_2$ chemistry slows down the conversion of NO to NO$_2$ and leads to lower O$_3$ concentrations in all NO$_x$-RH conditions considered (lower by 2% at steady state). However, the reactions responsible for the change are slightly different in low and high NO$_x$ environments.

We implement the new mechanism into the UKCA model, validate the model with ground-based, ship and aircraft observations of RONO$_2$ and their parent alkanes and evaluate the impact of C$_1$-C$_5$ RONO$_2$ chemistry on O$_3$, HO$_x$ and NO$_x$ burdens and distribution.