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The impacts of VOCs on atmospheric chemistry: The Common Representatives Intermediates Chemical Mechanism in UKCA

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Ozone production in the troposphere is driven by the photo-oxidation of volatile organic compounds (VOCs) in the presence of NO_x. However, there are many thousands of VOC species in the atmosphere, and the simulation of all these species and their products is not feasible in 3D models. Various techniques for reducing complexity are used, but these introduce errors that are hard to identify. The Master Chemical Mechanism (MCM) is a near- explicit scheme, with several thousand species and 10s of thousands of reactions, but is almost exclusively used in box-model applications due to its high cost. The Common Representative Intermediates (CRIv2-R5) mechanism is an effective compromise, preserving the ozone forming potential of the MCM whilst reducing the number of species and reactions to be feasible in a 3D model (approximately 240 species, 650 reactions), whereby it can be used as a benchmark to assess simpler schemes in realistic, 3D modelling environments.

We present the first results of simulations using CRIv2R5 in a global chemistry-climate model, the United Kingdom Chemistry and Aerosol model (UKCA). The CRI scheme is first implemented in a Box-Model version of UKCA, to test the scheme under a range of idealised chemical environments. It is further run in the full 3D modelling suite, using equivalent emissions and settings for a present-day scenario for the Coupled Model Intercomparison Project (CMIP6) to enable a broad scope of other model simulations and observations to evaluate the model changes against. Differences attributable to the chemical mechanism for key chemistry-climate processes, such as tropospheric ozone production, the OH radical burden and lifetime of methane, are investigated. Comparisons of CRI-UKCA runs with standard CMIP6 simulations highlight the importance of including a wide suite of emitted VOCs for modelling tropospheric ozone. Although the total burden of tropospheric ozone differs by only a few percent, the budget terms for ozone are remarkably different, questioning the reliability of the current CMIP6 generation chemistry schemes for simulating ozone trends.