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Impact of elevated water vapour on ozone in the mid-latitude lower stratosphere in summer

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Due to the occurrence of convective overshooting events in mid-latitude summer, water can be transported from the troposphere into the stratosphere. An enhancement of water vapour could affect ozone in the lowermost stratosphere. However, the chemical mechanism of the associated potential ozone loss process has not yet been analysed in sufficient detail and its sensitivity to temperature and air composition is not yet clear. The transport of sulfur into the lowermost stratosphere due to volcanic eruptions or the application of sulphate geoengineering could affect this ozone chemistry as well. We investigate this ozone chemistry and its sensitivity to temperature, water vapour, sulphate aerosols, and other trace gases (as Cly and NO_y) conducting a box-model study with the Chemical Lagrangian Model of the Stratosphere (CLaMS). Chemistry is simulated along a 7-day backward trajectory and initialized using measurements performed during the Study of Emissions and atmospheric Composition, Clouds and Climate Coupling by Regional Surveys (SEAC4RS) aircraft campaign (2013, Texas). Focussing on a realistic trajectory in a temperature range from 197–203 K, a threshold in water vapour of 11.0–11.6 ppmv was found, which marks the shift between ozone formation and ozone destruction. We show that this threshold is mainly determined by the temperature and the sulphate content. However, the amount of ozone loss depends on trace gases (Cly, NO_y, Bry) and the duration of the time period over which conditions leading to ozone depletion can be maintained.