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Model simulations of stratospheric ozone loss caused by enhanced H2O due to increased H2 emissions during the Arctic winter 2004/2005

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Stratospheric simulations with the Chemical Lagrangian Model of the Stratosphere (CLaMS) were performed within the EUROHYDROS project to study the impact of potential future stratospheric H_2O increases due to potentially increased H_2 emissions during the Arctic winter 2004/2005. For that, full hydrogen-relevant chemistry was incorporated into the model. First, box model studies for a single ascending air parcel in the tropical stratosphere were used to estimate the oxidation of H_2 and CH_4 and the inferred additional H_2O production from potential increased H_2 emissions. This study is based on four H_2 scenarios that reflect the ongoing discussion about the potential increase of atmospheric H_2 due to leakages caused by a future hydrogen economy. In our study we use the H_2 scenario with the highest additional amount of H_2O up to 0.56 ppmv for Arctic winter conditions. It has been asserted that this case is unrealistic due to the high leakage rate assumption, nevertheless in our studies this case is used as upper limit to calculate the expected future maximum ozone loss caused by enhanced H_2O due to increased H_2 emissions. We compare simulated ozone loss for the Arctic winter 2004/2005 which shows a very good agreement with satellite measurements to simulated ozone loss with enhanced stratospheric H_2O values. Locally up to 6 – 7% more ozone loss is deduced in the simulations with enhanced H_2O mixing ratios and up to approximately 7 DU higher ozone loss for the Arctic polar winter 2004/2005. This case is a clear upper limit of future potential ozone loss caused by increasing H_2O values due to H_2 emissions. However, enhanced H_2O values have also an impact on the radiative forcing of the atmosphere, therefore the decrease in temperature will be also considered. Overall, increasing H_2 emissions due to leakages caused by a future hydrogen economy is an additional variability