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Investigation of stratospheric HDO/H2O variations in EMAC model simulations

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Studying the isotopic composition of water vapour in the upper troposphere and lower stratosphere can help to explain the driving mechanisms of changes in the stratospheric water vapour budget. We equipped the global climate chemistry model EMAC with a description of the water istopologue HDO, comprising its physical and chemical fractionation effects in order to investigate the processes responsible for the stratospheric HDO/H2O patterns and their variations. Discrepancies in the tape recorder signal in water vapour isotope ratios between MIPAS and ACE/FTS satellite retrievals can partly be explained through these model simulations. Moreover, a sensitivity experiment shows that fractionation effects during the oxidation of methane have a damping effect on the tape recorder signal and overshadow it in the upper stratosphere. Investigating the origin of the isotope ratio tape recorder, we reveal that in-mixing of old stratospheric air from the extratropics and the intrusion of tropospheric water vapour into the stratosphere complement each other for the generation of the high isotope ratios in the tropical stratosphere during boreal-summer. For this, the effect of ice lofting in monsoon systems is shown to play a crucial role. Furthermore, we describe a possible pathway of isotopically enriched water vapour in the outflow region of the monsoon systems through the tropopause into the tropical stratosphere. This study of global chemistry climate model simulations with water isotopologues constitutes the foundation for further analyses in order to determine the connection between the patterns and changes in stratospheric water vapour and its isotope ratio. Hereby, a better understanding of the reasons for the trends and variations in the stratospheric water vapour budget can be gained.