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Estimating the contribution of bromoform to stratospheric bromine and its relation to dehydration in the tropical tropopause layer

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Abstract. The contribution of bromoform to the stratospheric bromine loading is estimated using the one-dimensional tropical mean model of Folkins and Martin (2005), which is constrained by observed mean profiles of temperature and humidity. In order to reach the stratosphere, bromoform needs to be lifted by deep convection into the tropical tropopause layer (TTL), above the level of zero radiative heating. The contribution of bromoform to stratospheric bromine then depends critically on the rate of removal of the degradation products of bromoform (collectively called Br_y here) from the TTL, which is believed to be due to scavenging by falling ice. This relates the transport of short-lived bromine species into the stratosphere to processes of dehydration in the TTL. In the extreme case of dehydration occurring only through overshooting deep convection, the loss of Br_y from the TTL may be negligible and consequently bromoform will fully contribute with its boundary layer mixing ratio to the stratospheric bromine loading, i.e. with 3 pptv for an assumed 1 pptv of bromoform in the boundary layer. For the other extreme that Br_y is removed from the TTL almost instantaneously, the model calculations predict a contribution of about 0.5 pptv for the assumed 1 pptv of boundary layer bromoform. While this gives some constraints on the contribution of bromoform to stratospheric bromine, a key uncertainty in estimating the contribution of short-lived bromine source gases to the stratospheric bromine loading is the mechanism and rate of removal of Br_y within the TTL.

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