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Probing the tropical tropopause layer for organic and inorganic bromine

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Bromine chemistry impacts the levels of O₃ in the UT/TTL/LS. This region is also known to serve as a gateway for delivery of O₃ depleting gases to the stratosphere. CH₃Br, halons, and short-lived organic bromine precursors (VSLs), such as CHBr₃, CH₂Br₂, and possibly inorganic product gases have been identified as the main Br gases delivered to the stratosphere. However, many important details of the transport and delivery of VSLs and inorganic Br compounds through the TTL are still uncertain. Moreover, a number of chemical processes, including the transformation of the source gases and cycling of inorganic bromine species at low ambient temperature and on ice particles are also poorly understood.

The presentation reports measurements of CH₄, O₃, NO₂, and BrO performed by different instruments and techniques during the 2013 NASA-ATTREX flights in the TTL and LS. The interpretation of our measurements is supported by chemical transport model (SLIMCAT) simulations. SLIMCAT results, in conjunction with extensive RT calculations using the Monte Carlo model McArtim, also are used to improve retrieval of O₃, NO₂, and BrO concentrations from limb scattered sunlight measurements made with the Differential Optical Absorption Spectroscopy (DOAS) technique during ATTREX. The model also allows us to attribute observed concentration variations to transport and to photochemical processes. When properly accounting for the transport-related concentration variations in CH and O₃, we find that measured BrO is mostly larger than model simulations which use recommended JPL-kinetic data. When the errors and uncertainties in the involved photochemical reaction rates, which are mostly available for higher T_s than those (> 188K) encountered during the NASA ATTREX mission, are accordingly considered in the calculation of the Br partitioning, the total Br in the TTL can be quantified to 21±1 ppt in 2013.