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Water vapour as indicator of stratospheric circulation changes

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Water vapour is the most important natural greenhouse gas in the atmosphere and provides a positive feedback to the climate forcing from carbon dioxide. Water vapour is also the source of hydroxyl (OH) which controls the lifetime of shorter-lived pollutants and long-lived greenhouse gases. Despite the importance of water vapour to chemistry and the radiative balance of the atmosphere, its observed long-term changes in the stratosphere are not well understood.

The longest available record from balloon observations over Boulder (Colorado, USA) shows increases in stratospheric water vapour concentrations that cannot be fully explained by observed changes in its main drivers, tropical tropopause temperatures and tropospheric methane increases. Satellite observations may help resolve the issue, but constructing a reliable long-term data record from individual short satellite data sets is challenging. A new approach to merge satellite data sets is introduced which uses a chemistry–climate model nudged to observed meteorology as transfer function between the water vapour timeseries from different instruments. The new approach helps to gain confidence in the measurements and to identify existing problems in the datasets. Analysis of long-term changes in the newly merged stratospheric water vapour data record reveals a different behaviour to that derived from the Boulder observations, implying that the Boulder trend is not representative for the zonal mean stratosphere and providing new observational evidence for stratospheric circulation changes.