



The first climatology of stratospheric SO₂

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Sulphur dioxide (SO₂) is one of the key species determining the aerosol content of the stratosphere. Apart from this study, only three measured profiles of SO₂ concentrations (by ATMOS) covering the altitude range of the stratosphere have been published, two of which are heavily perturbed by the Pinatubo eruption and one by El Chichon. Here we present a climatology of monthly and 10° zonal mean profiles of SO₂ volume mixing ratios in the altitude range 15-45 km as derived from MIPAS/Envisat measurements from July 2002 until April 2012. The vertical resolution varies from 3.5-4 km in the lower stratosphere up to 6-10 km at the upper end of the profiles with estimated total errors of 5-20 pptv for background conditions of SO₂. Comparisons are made with few available observations of SO₂ up to high altitudes from ATMOS, for volcanically perturbed situations in the lower stratosphere from ACE-FTS and at the lowest altitudes with stratospheric in-situ observations. The dataset proves for the first time several features of the stratospheric SO₂ distribution, which up to now, have only been shown by models: (1) the local maximum of SO₂ at around 25-30 km altitude from conversion of COS as the precursor of the Junge layer and (2) the downwelling of SO₂-rich air to altitudes of 25-30 km at high latitudes during winter and its subsequent depletion during spring as cause for the sudden appearance of enhanced concentrations of condensation nuclei. Comparison with model results of SO₂ from the SPARC aerosol assessment report indicate several inconsistencies between simulations and our observations. Further, dedicated EMAC model runs reveal that the strong increase of SO₂ to values of 80-100 pptv in the upper stratosphere can only be explained by taking into account visible and near-IR photolysis of H₂SO₄ and, in addition, a meteoritic sink. Lower stratospheric variability of SO₂ can mainly be explained by volcanic activity. A modulation of the mid-stratospheric maximum could be observed for several equatorial eruptions during the time period of observations.