



A growing threat to the ozone layer from short-lived anthropogenic chlorocarbons

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Abstract. Large and effective reductions in emissions of long-lived ozone-depleting substance (ODS) are being achieved through the Montreal Protocol, the effectiveness of which can be seen in the declining atmospheric abundances of many ODSs. An important remaining uncertainty concerns the role of very short-lived substances (VSLs) which, owing to their relatively short atmospheric lifetimes (less than 6 months), are not regulated under the Montreal Protocol. Recent studies have found an unexplained increase in the global tropospheric abundance of one VSL, dichloromethane (CH_2Cl_2), which has increased by around 60 % over the past decade. Here we report dramatic enhancements of several chlorine-containing VSLs (Cl-VSLs), including CH_2Cl_2 and $\text{CH}_2\text{ClCH}_2\text{Cl}$ (1,2-dichloroethane), observed in surface and upper-tropospheric air in East and South East Asia. Surface observations were, on occasion, an order of magnitude higher than previously reported in the marine boundary layer, whilst upper-tropospheric data were up to 3 times higher than expected. In addition, we pro-

vide further evidence of an atmospheric transport mechanism whereby substantial amounts of industrial pollution from East Asia, including these chlorinated VSLs, can rapidly, and regularly, be transported to tropical regions of the western Pacific and subsequently uplifted to the tropical upper troposphere. This latter region is a major provider of air entering the stratosphere, and so this mechanism, in conjunction with increasing emissions of Cl-VSLs from East Asia, could potentially slow the expected recovery of stratospheric ozone.

1 Introduction

Large-scale ozone depletion in the stratosphere is a persisting global environmental problem. It is predominantly caused by the release of reactive chlorine and bromine species from halogenated organic compounds. Although the basic science is well established, there remains significant uncertainty sur-