A quantitative estimation of the transport of surface emissions from high population density regions into the stratosphere

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The transport of chemical compounds from surface emissions into the stratosphere is very important for stratospheric, and even global, climate change. However, the lack of observational data makes it is difficult to trace these emissions back to specific regions. This study uses numerical simulations to investigate the transport of surface emissions from high population density regions into the stratosphere. The selected regions are: East Asia, Southeast Asia, Southwest Asia, Europe, Africa, South America, North America, and Oceania. Tracers are used to represent surface emissions in the model, and are synchronously released at the same rate over the eight study regions. In spring, Southeast Asia and Oceania tracers contribute ~⅓ and ~¼ of total tracers entering the stratosphere, respectively. In summer, Southwest Asia contributes ~½ of the total, which is far more than the contribution of all other source regions. In fall, South America and Southeast Asia each account for ~¼ of the total tracer budget. In winter, Oceania and Southeast Asia each account for ~¼ of all tracers entering the stratosphere. In terms of average contributions, Southeast Asia contributes 27.6%, Oceania contributes 18.1%, Southwest Asia contributes 4.9%, Africa contributes 10.6%, South America contributes 9.6%, East Asia contributes 8.5%, North America contributes 7.4%, and Europe contributes 3.2% of total tracers entering the stratosphere. A further quantitative estimation illustrates that the average seasonal proportion of a tracer entering the stratosphere compared with its total release is 2.6% from Southeast Asia, followed by 1.7% from Oceania, 1.4% from Southwest Asia, 1.0% from Africa, 0.9% from South America, 0.8% from East Asia, 0.7% from North America, and 0.3% from Europe.

Key words: WACCM4, Surface emissions, Regions of high population density, Stratospheric transport