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The impact of Eastern U.S. megapolis emissions on carbon monoxide and ozone concentrations over Europe

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While there exist many model and case studies of intercontinental transatlantic transport, to date no statistical analyses of measurement data over Europe exist, which analyze the influence of North American emission sources. In particular, the influence of the large emissions of the North American East coast megapolis (Boston, New York, Washington, named Bosnywash in the following) on atmospheric composition over Europe has never been assessed. In this study, we used a large data set of carbon monoxide (CO) and ozone measurements to examine the influence of Bosnywash emissions on the chemical composition of the atmosphere over Europe.

We analyzed 5 years (2004-2009) of CO and ozone measurements from the MOZAIC programme taken during ascent and descent from European airports of commercial airliners equipped with instruments measuring meteorological parameters as well as some trace gases. We determined the source regions influencing the measurements with the Lagrangian particle dispersion model FLEXPART. CO and ozone data were averaged over 1 km high layers during ascent and descent and for each individual 1-km-averaged measurement, 40000 particles were released and followed 20 days backward in time. For the entire 5-year period, we performed backward calculations for 80000 measurements. Using the EDGAR emission inventory and the FLEXPART backward calculation, CO concentration as predicted by the model could be derived. Comparing the modeled and simulated CO values shows that measured CO and modeled CO enhancement are well correlated and, thus, that the model captures the relevant transport processes.

Subsequently, we grouped the MOZAIC measurements according to the dominant source regions, distinguishing between European and North American-dominated measurements as well as Bosnywash-dominated measurements, respectively. A seasonal analysis shows that there are clear differences in the ozone to CO ratio depending on the source region. The importance of the North American emissions for Europe shows a weak seasonal variation. Altitudes and regions which receive the highest pollution load from intercontinental transport are identified. The importance of the Bosnywash area compared to all North American emissions will be discussed.