



Decadal trend in springtime tropospheric ozone at a mountainous site in Japan: 1998-2007

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The trend of tropospheric ozone from 1998 to 2007 was examined based on continuous measurements made at a mountainous site on Mt. Happo (36.69 degN, 137.80 degE, 1850 m asl.), Japan. We focused our study on springtime ozone, to coincide with the East Asian continental outflow that dominates the lower tropospheric ozone over Japan during this season. The observed increase of ~ 1 ppbv per year in the mean ozone level was statistically significant. We also found that the probability distribution of the springtime ozone mixing ratios was substantially modified, with the ozone mixing ratios greatly increasing at the upper end of the probability distribution. This increase has been particularly large since 2003, with larger increases occurring at the higher percentiles. The number of high-ozone days doubled during 2003–2007 compared to 1999–2002. One of the very likely explanations is the enhancement of regional ozone pollution due to rapidly increasing anthropogenic emissions from East Asia.

We use a regional chemistry-transport model to explore the observed changes and how changes in Asian anthropogenic emissions have contributed to the observed increasing trends at Mt. happo. The model with yearly-dependent regional emissions successfully reproduces the levels, variability, and interannual variations of ozone. It predicts increasing trends at Mt. Happo, suggesting that increasing Asian anthropogenic emissions account for about half the observed increase. However, the discrepancy between the observation and model results after 2003 (the time of largest emission increase) suggests significant underestimation of the actual growth of the Asian anthropogenic emissions and/or incompleteness in the modeling of pollution export from continental Asia.